NH Education and Environment Team
NH Field Investigations Model

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Precipitation Data by Rain Gage, 1956-2007
Hubbard Brook Experimental Forest
Woodstock, NH

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NH Education and Environment Team

The NH Education and Environment Team (NHEET) is a public-private collaborative of state-based, teacher professional development providers in the fields of environmental education, natural science, and scientific inquiry. Members include the GLOBE Program, Project HOME, Project Learning Tree, Project WET at NH Department of Environmental Services, Projects WILD and Aquatic WILD at NH Fish and Game Department, and the US Forest Service. Our mission is to support schools and teachers to provide their students with the resources and opportunities to be skilled and knowledgeable stewards of our natural environment.

Using Field Investigations to Model Scientific Inquiry

State and national science standards emphasize the importance of inquiry and problem-solving for today's students. Field investigations offer rich opportunities for students to practice inquiry in engaging and authentic ways. Key steps in field investigations mirror the inquiry process. They are posing research questions, planning and conducting investigations, using evidence to describe findings, communicating research findings to target audiences, and asking new research questions based on findings.

Field Investigations in NH

Just as New Hampshire is gifted with abundant natural resources, so too do we benefit from plentiful scientific field investigations. Several ongoing investigations are offered as models to guide teachers and their students through an authentic scientific inquiry process.

This model describes a study of precipitation collected at several rain gages in the Hubbard Brook Experimental Forest in central NH. These data are collected to assess change over time. This model is recommended for high school use.

Another model recommended for high school use is maximum and minimum air temperature data collected at Hubbard Brook Experimental Forest.

The Winter Severity Index is recommended for middle school use. It provides a subset of data used by the NH Fish and Game Department to assess how the severity of winter may impact deer populations.

A model recommended for elementary school use presents data on the species of birds observed from Project Feeder Watch. (This model is still in development.)

All models and accompanying spreadsheets are available at www.nhplt.org. Funding for their development and distribution was provided by the federal Math-Science Partnership grant program.

Field Investigation Design

Research Question

Has daily precipitation in millimeters (mm) at established rain gage sites at Hubbard Brook Experimental Forest changed over time?

How Does the Data Answer the Question?

This dataset is used to understand long-term precipitation trends at the Hubbard Brook Experimental Forest (HBEF) and is used by scientists to predict how other ecosystem processes will respond to future climate change. This data is also used by scientists to study the relationship between streamflow and evapotransporation (water evaporated directly from the leaves, soil, or snow).

About the Data

The *Precipitation by Gage* dataset available on the Hubbard Brook Ecosystem Study (HBES) website, www.hubbardbrook.org, provides daily precipitation data collected at rain gages placed throughout the HBEF. The rain gages are located at varying altitudes in and around each of the nine watersheds in the HBEF. The data were collected starting in 1956. The accompanying dataset provides the data in an *Excel* spreadsheet with the total precipitation at each rain gage for each year that the data has been collected. Also included is a spreadsheet with the yearly totals for selected rain gages at varying altitudes, and monthly totals at each rain gage for all of the years that data has been collected. Months are designated by the corresponding number (i.e. January= 1, February = 2, March = 3, etc.) for ease of sorting the data. Rain gages are referred to by number (i.e. RG1, RG2, etc.).

Study Protocol

Precipitation is measured at Hubbard Brook by a network of 7 weighing-recording rain

gages and 24 standard rain gages. During winter months (Nov-Mar), all gages are charged with antifreeze and operated with funnels removed. The analog charts on the recording gages are changed about weekly, at which time the accumulation in the standard gages is measured. The daily recording data and "weekly" standard gage data are entered into the computer. Missing data are filled by estimation from nearby gages. A computer program uses the recording gage data to prorate the standard gage data into daily amounts.

Weekly precipitation data is collected at a network of standard rain gages from 1956 to the present. Daily values are obtained by prorating, using daily values from weighing-recording rain gages.

Notes on Data

The physical location of stored data is the USDA Forest Service in Durham, NH.

Note: RG18 has been taken down since the beginning of the study, so the location, latitude, longitude and altitude applying to it are no longer relevant information for current and future data.

Data used in this publication were obtained by scientists of the Hubbard Brook Ecosystem Study; this publication has not been reviewed by those scientists. The Hubbard Brook Experimental Forest is operated and maintained by the Northern Research Station, U.S. Department of Agriculture, Newtown Square, Pennsylvania. Please note that data sharing and availability policies vary among the datasets available. Publishers of Hubbard Brook data are encouraged to contact the original data provider to obtain information for an acknowledgement of the original funding source of the research. This information is available from the HBES website at www.hubbardbrook.org.

Examples of Data Analysis

Students may analyze these data in many ways. The following are suggestions and not the only way to visually represent the data.

Graphing the data over time will help students look for trends and variation over time in the data. Graphing data in series will allow for comparative analysis of precipitation at different sites. Using the information about the elevation of each rain gage, students may analyze the relationship between elevation and precipitation. Sorting data by year allows students to create graphs of data over the course of a given year and to compare data for selected years in series. Sorting data by month allows for analysis of data over time for a specific month. Students may also analyze the data with related data sets from HBEF, including air temperature, streamflow, and evapotransporation data.
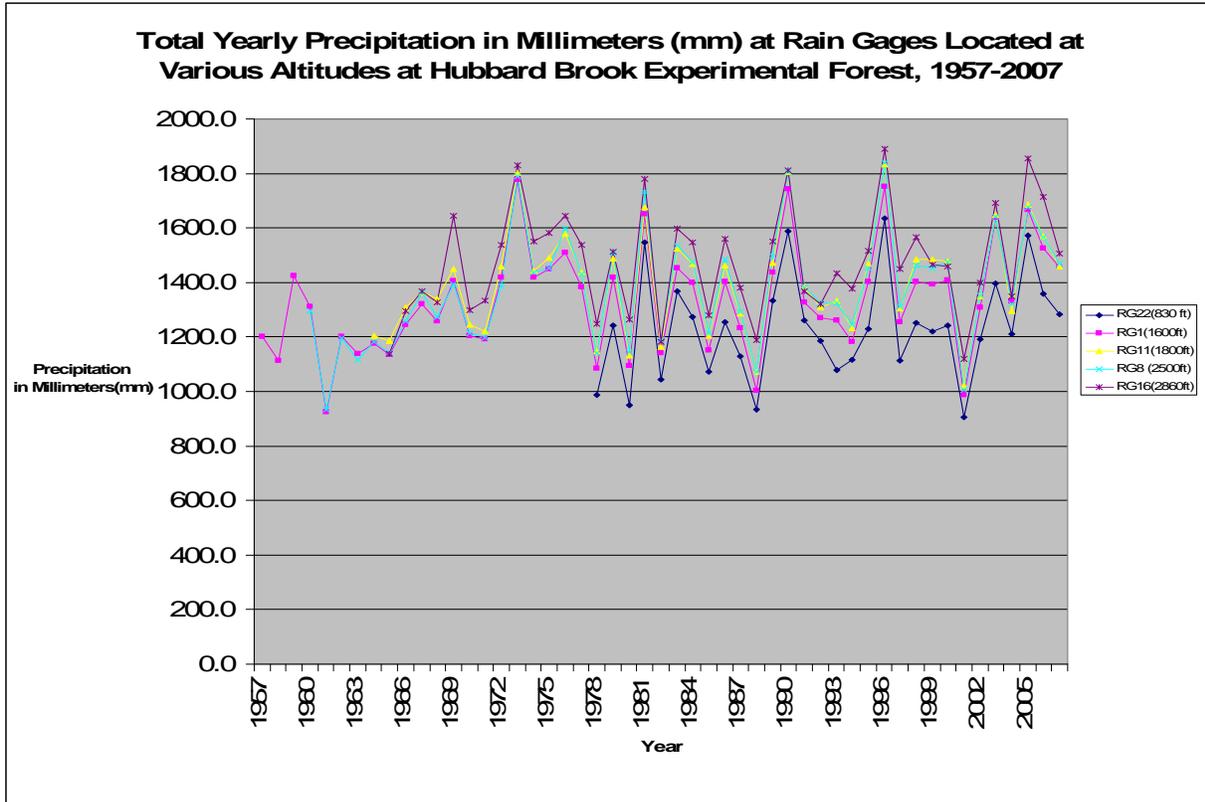
Examples of Questions for Data Analysis

The following are examples of questions that may guide students in analyzing data. Many more questions may be asked and students should be encouraged to formulate their own questions as they work with the data. Students should also be encouraged to explore the Hubbard Brook Ecosystem Study website, www.hubbardbrook.org for answers to questions about the data and for more information about the study site.
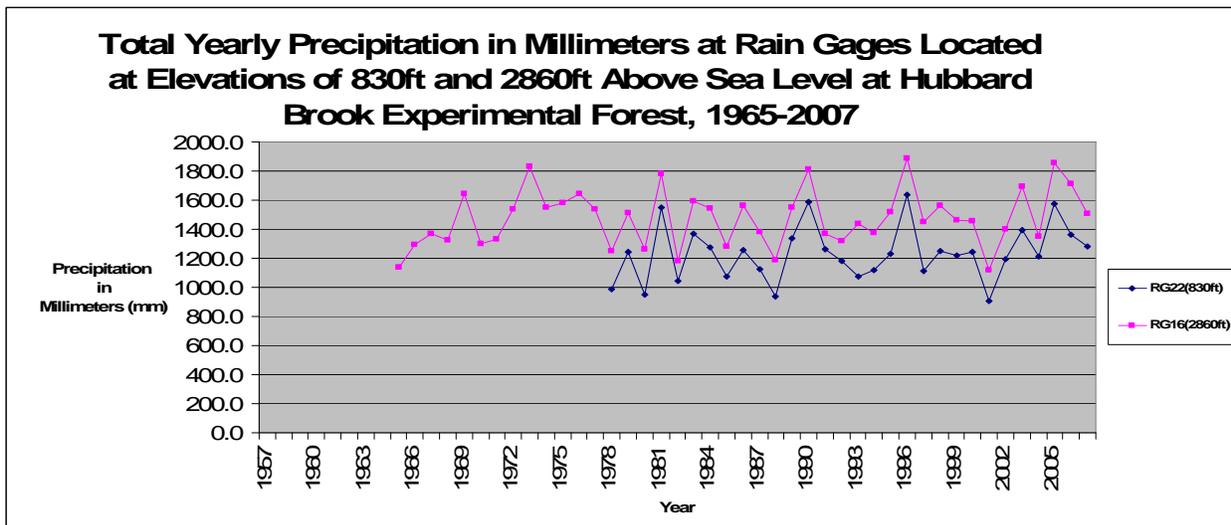
- What is the range of variation in annual total precipitation over the years that the data was collected?
- During which years are there extreme highs or lows?
- During which months is there the most variation in precipitation? The least variation?
- What are changes in the data over the length of the study?
- What are patterns in the data over time?
- Is there a relationship between elevation and the amount of precipitation?
- What statistical tests could you perform on this data?
- What questions do you have about this data?
- What other data would be helpful to compare with this data?

Examples of Graphs

Example 1: This graph was created in Microsoft Excel by using the line chart function and graphing selected rain gage data over time in a series.

Total Yearly Precipitation in Millimeters (mm) at Rain Gages Located at Various Altitudes at Hubbard Brook Experimental Forest, 1957-2007

Example 2: This graph was also created using a line chart function and selecting only two series of data. Students should observe that decisions about the amount of data to graph and the size and layout of the graph will affect their ability to visualize patterns and relationships.

Total Yearly Precipitation in Millimeters at Rain Gages Located at Elevations of 830ft and 2860ft Above Sea Level at Hubbard Brook Experimental Forest, 1965-2007

Example 3: This graph shows the data for the month of February at Rain Gage 1 for the length of the study. Students should observe outlier years, make comparisons to precipitation trends in other months, or compare this data to precipitation at other rain gages for the same month.

February Precipitation at Rain Gage 1 (RG1), Hubbard Brook Experimental Forest, 1956-2007
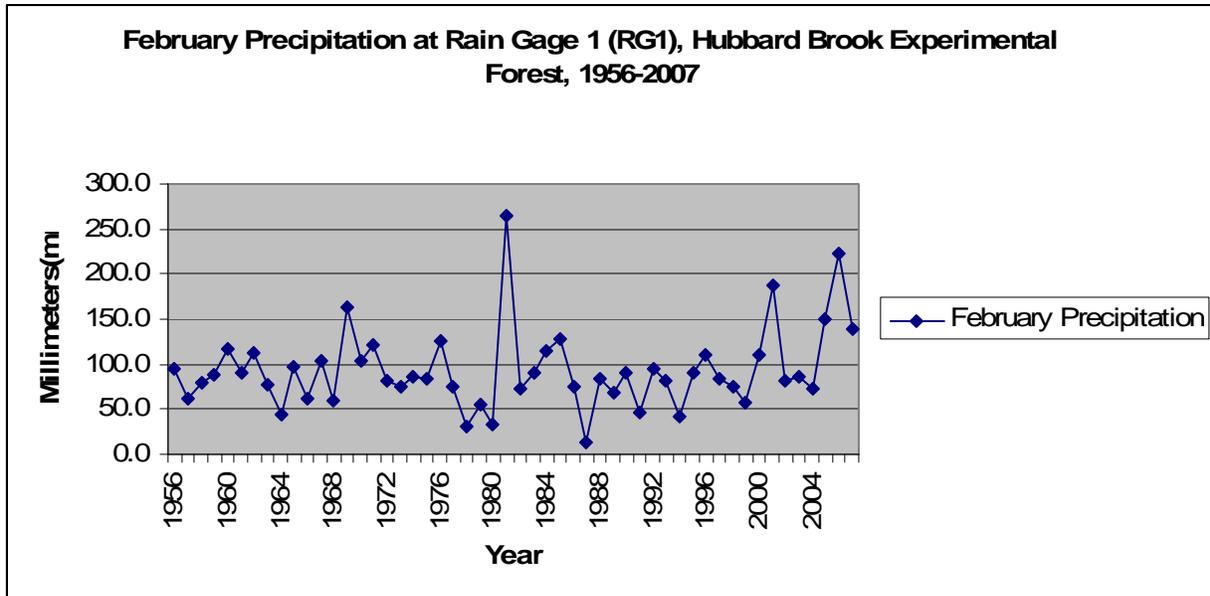
Resources

Hubbard Brook Ecosystem Study, www.hubbardbrook.org. The Hubbard Brook Ecosystem Study (HBES) sustains long-term ecological research within the Hubbard Brook Experimental Forest, located in the towns of Ellsworth, Thornton, and Woodstock. On-site research has produced some of the most extensive and longest continuous data bases on the hydrology, biology, geology and chemistry of a forest and its associated aquatic ecosystems.

Hubbard Brook Experimental Forest, http://nrs.fs.fed.us/ef/locations/nh/hubbard-brook/. The Hubbard Brook Experimental Forest is a 3,160 hectare reserve in the White Mountain National Forest, managed by the USDA Forest Service Northern Research Station. It was established in 1955 as a major center for hydrologic research in New England.

Colburn, E. 2009. **Show Me A Picture, Tell Me A Story; An Introduction to Graphs for the Analysis of Ecological Data from Schoolyard Science Research Studies**. http://harvardforest.fas.harvard.edu/museum/data/k12/Colburn%202009%20Graphing%20Manual.pdf

Colburn, E. 2009. **Graphing Exercises**. http://harvardforest.fas.harvard.edu/museum/data/k12/Colburn%202009%20Graphing%20Exercises.pdf