REPORT: Les Mehrhoff Botanical Research Fund

Data analysis of forest seeps in New Hampshire

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Seeps are places where the groundwater emerges gently at the surface. They may be perennial or ephemeral, emerging through soil or rocks. Although seeps are quite common in the Northeast, little is known, or at least published, on seeps in the region. In 2002, I started to gather some basic data on seeps in New Hampshire. This report summarizes the data and gives partial answers to the original questions I had about seeps. The next steps are to complete data analysis, study the correlations, reflect on their possible causes, and plan future work.

Data Collection

With advice from Scott Bailey (research geologist for the USDA Forest Service), I selected four New Hampshire locales that had different bedrock that weathers in different ways. Here are the sites.

- Bear Brook State Park, Merrimack Co. (Concord Granite)
- Hubbard Brook Experimental Forest, Grafton Co. (Rangeley Formation)
- Bunnell Preserve, Coos Co. (hornblende syenite)
- A Nature Conservancy property near Crommet Creek, Strafford Co. (Kittery Formation and Exeter Diorite)

I chose sixteen seeps, three to five in each locale. Seep size ranged from about 20 to 900 square meters. The main seep-selection criteria were low-volume perennial flow; a forested site; a source that appeared to be predominately groundwater rather than runoff or standing water; and no recent anthropogenic disturbance. In 2002/2003, I collected environmental and water data at each season, developed nondestructive study methods, and described the plants and bryophytes in the seeps and their surrounding natural community. In all this, I was enthusiastically assisted by Sara Cairns (data manager for the New Hampshire Natural Heritage Bureau).

Data collected at study seeps, 2002–2004

Data collected in May, August , November, and February 2002/3

- Water samples at one or more source points: analyzed for pH, specific conductance, and ions (Al, Ca, Cl, Fe, K, Mg, Na, NH_4, NO_3, Si, SO_4)[1]
- Relative above-ground flow of a seep[2]
- Temperature of soil and water

Other data collected from 2002 to 2004

- All vascular plants in seep: species and percent cover (visual estimate)
- Vascular plants in surrounding forest: species and percent cover (visual estimate) in a 10-by-10-meter plot
- Dominant bryophytes in seep: species and percent cover (visual estimate)
- Map of seep boundary[3]
- Canopy photos to measure available light in growing season

- Community relevé for each seep[4]
- Community relevé for the surrounding forest
- Soil profile in the forest upslope from the seep[5]

[1]Water samples were collected at the highest point where water flowed from the ground. Lab equipment and tests were courtesy of Scott Bailey.

[2]Measured with a miniweir invented by Sara Cairns.

[3]I used the root mat and soil characteristics down to about 20 centimeters to delimit the seep boundary.

[4]These relevés include vegetation structure, elevation, latitude and longitude, aspect, and slope.

[5]To minimize disturbance, I did not dig soil pits within the seeps.

Original Questions and Analysis

Does seep water chemistry vary during the year? If so, which ions vary and how much?

The water chemistry of the seeps did not vary by season. Nor was there significant variation over the year when I lumped all the seeps together. Some seeps had tremendous variation in above-ground water flow, while other seeps were quite constant. However, specific conductance and pH did not change significantly.

Although I tried to select perennial seeps in the spring of 2002, six seeps had no visible flow for one or more of the later collecting dates.

Does water chemistry vary among sites?

Yes. As is typical for seeps on New Hampshire bedrock and soils, specific conductance was low everywhere. Specific conductance was closer to the range for precipitation (<21 microsiemens/centimeter) than to freshwater streams (50–1,500 µS/cm); the highest specific conductance in these sixteen seeps was 69 µS/cm. It was highest for a group that included the coastal, southern seeps and one northern seep (above Hubbard Brook Gorge [HBG1]). Water chemistry alone did not sort the remaining seeps into groups.

The ions that correlated closely with high specific conductance were Ca, Mg, Na, and K. Other patterns that appeared were a positive correlation between pH and Si and SO_4.

Some outliers: Chloride ion concentration was highest in the four seeps nearest roads. The seep at the highest elevation (994 meters) had an unusually high concentration of NO_3. HBG1 had the highest pH: 7.21 for the year. Other seeps ranged from pH 5.57 to 6.38.

Do the resident vascular plants vary with the water chemistry of the seep? Do bryophytes?

Cluster analysis, based on vascular plants and dominant mosses that occurred in two or more seeps, grouped most seeps by locale. This is not surprising, given that suites of species change with latitude and elevation and that local pools of available propagules differ by chance. However, one northern seep (HBG1) clustered with the coastal, southern seeps.

Cluster analysis of the seeps based on water chemistry found two distinct groups. As in the cluster analysis based on plant species, HBG1 and the coastal, southern seeps were in one group. Unlike the plant analysis, the water chemistry for the rest of the seeps varied in each locale, with no clear similarities. It seems possible that relatively high calcium concentration is driving the vegetation similarity for the five-seep group.

The bryophyte data are insufficient to answer this question.

What environmental variables are correlated with species richness and particular species?

Species richness was gauged by number of species in each seep; as expected, the number of species in a seep correlated to the area of the seep. Overall, plant diversity was impressive: 89 species of vascular plants and dominant mosses were found in only one seep, compared to 149 in two or more seeps.

Species richness correlated negatively with elevation and latitude, correlated positively with specific conductance and calcium in the water, and did not correlate with pH, aspect, or slope.

Most seeps clustered with the others in that locale when ordinated by the plants in them. The only exception to this was HBG1.

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