Hubbard Brook Watershed Report - WY2023



What is HBWatER? The Hubbard Brook Watershed Ecosystem Record is a dataset of chemical concentration data for precipitation and streamwater samples that have been collected weekly since the summer of 1963 from streams and precipitation gauges throughout the Hubbard Brook Experimental Forest, a research forest in the White Mountains of New Hampshire. HBWatER currently collects weekly samples from nine gauged watersheds, the mainstem of the Hubbard Brook into which each small stream drains, and three long-term precipitation collection sites.

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A brief history: In 1963, 4 visionary scientists (Gene E. Likens, F. Herbert Bormann, Robert S. Pierce, and Noye M. Johnson) began collecting and analyzing stream water and precipitation (rain and snow) at a Forest Service property in the White Mountains of New Hampshire. They had a simple idea, that by comparing watershed inputs in rain and snow to watershed outputs from streams, they could measure the behavior of entire ecosystems in response to atmospheric pollution or forestry practices. The record they began in 1963 has been added to every week up to the present day. Insights gained from studying this long-term chemical record led to the discovery of acid rain in North America and documented the effectiveness of federal clean air legislation in reducing coal-fired power plant emissions see the Figure on the right. This long-term record has become one of the most iconic and influential environmental data sets, featured in hundreds of scientific and popular press articles.



These graphs show us: (1) the amount of weekly precipitation as rain or snow; (2) the concentration of sulfates in streamwater (navy) and precipitation (blue); (3) the pH of streamwater (navy) and precipitation (blue); and (4) the total streamflow every week since July 1963. Notice that precipitation and streamwater has become less acidic and lower in sulfates over time.

The collection and analysis of HBWatER samples is currently sustained by Tammy Wooster (Cary IES) and Jeff Merriam (USFS) and the dataset is curated and maintained by a team of researchers: Chris Solomon (Cary IES), Emily Bernhardt (Duke), Bill McDowell (UNH), Charley Driscoll (Syracuse U.), and Mark Green (Case Western). Current Financial Support for HBWatER is provided by NSF LTREB # 1907683 and the USDA Forest Service Northern Research Station.

What can we learn from measuring the chemistry

of a river? The graphs on this page show how the chemistry of one stream at Hubbard Brook changes over the course of a full year. First, check out the bottom axis. Our 'water year' begins on June 1, and is determined as the twelve-month period with the most consistent relationship between precipitation and streamflow across years. We use this water year because it minimizes variation due to catchment water storage (including water stored as snow) and evapotranspiration, and is, therefore, more hydrologically relevant than the calendar year.

In the top graph, note the opposing patterns of Silicon (Si) and Dissolved Organic Carbon (DOC). Silica is slowly released from granitic bedrock wherever rock is in contact with water. DOC is organic matter that is leached out of soil and leaves into soil solution (much like the flavor and color that leaches out when you put tea leaves or coffee grounds in water). Note that DOC goes up and Si goes down whenever stream flows are high (check navy line in the bottom graph). This graph shows us that at low flows, water in the stream is dominated by groundwater that has been in contact with rocks deeper in the soil. In contrast, during storms, more water enters the steam after flowing through organic-rich surface soils where leaves and roots accumulate. We can learn where water is coming from at any given time because of its different chemical signals.

Now that you have noticed this, you can see that some other solutes, like Sulfate and Sodium, are also lower in concentration whenever there are high flows. In contrast, Chloride, Calcium and Magnesium concentrations stay the same no matter what the flow. Check out that spike in Potassium that occurs in late Autumn. This is common in most years of the record and it's the result of Potassium ions being leached from all the leaves that fall from the trees into and alongside the stream each Autumn.



The final graph in this series shows us the temperature of stream water every Monday throughout the 2023 water year and the rate of streamflow measured on each sampling date. In WY2023 we captured large storms in late, a winter storm in December and a large snowmelt peak in April. Follow the July and April storm peaks from the bottom graph up through the solute graphs to see how chemistry shifts between low flow and peak flow.



Visit & Explore hbwater.org and macrosheds.org

Visit both of these platforms to play with the data in simple interactive windows. On hbwater.org you can read and use curated data stories and explore the full record of precipitation and streamwater chemistry and fluxes. On macrosheds.org you can make the same comparisons for HBEF alongside dozens of other federally funded watershed ecosystem studies across the United States - and you can easily access hydroclimatic and geospatial data for each of these watersheds.

We welcome collaborators and we encourage you to use the HBWatER dataset and visualization platform. The entire record is available for download. We only ask that you credit the source of the data by citing the record so that we can celebrate its use by others (and tell our funders about it).

Hubbard Brook Watershed Ecosystem Record (HBWatER). 2023. Continuous precipitation and stream chemistry data, Hubbard Brook Ecosystem Study, 1963 – ongoing. ver 9. Environmental Data Initiative. <u>https://doi.org/10.6073/pasta/f2fb8b6542106c6db534fab76decdcec</u>

We encourage you to use figures straight from our data visualization platform in talks and presentations, but, if you do, please credit HBWatER or the MacroSHEDS project. Feel free to let us know what would make it easier for you to make use of the dataset in your research, your classrooms and your own independent learning.

HBWatER LTREB Team: CoPIs: Chris Solomon (Cary IES) and Emily Bernhardt (Duke); Senior Personnel: Charley Driscoll (Syracuse U), Mark Green (Case Western), Bill McDowell (UNH); Field Operations: Tammy Wooster; Analytical Chemistry: Jeff Merriam (USFS); data management and visualization: Mike Vlah (Duke).

Macrosheds Team: Emily Bernhardt (Duke) and Matt Ross CSU(CoPIs); Mike Vlah - data scientist