Temperature is a fundamental environmental driver of physical, chemical, and biological processes—and global temperatures are currently increasing due to anthropogenic activities.

Due to its fundamental nature, a large body of research has studied the effects of temperature on processes of cells and individuals, and on populations growth rates and life history.

Theories of population level patterns suggest that species operate across a continuum of viable temperature with an optimal temperature of maximum performance. Further, temperature regimes are likely to determine patterns of organism metabolism, body-size, and in turn, fecundity.

However, many questions remain about how these population-level patterns with temperature scale up to whole communities.

Here we present a unique exploration of the patterns of whole community secondary production across a large natural temperature gradient within a small geographical area with similar biogeography and regional community pools. We use this setting to explore patterns of community production with temperature and how population patterns scale up h to whole communities at annual and seasonal scales.

Study site---

Our study site is located in the Hengill valley, outside of Reykjavik Iceland. This watershed consists of numerous springfed headwater streams that range in temperature from 5 to 35 Celsius, in a small geographical area. Importantly, the streams have a similar groundwater source and therefore have similar water chemistry, irrespective of temperature. Further, these temperature regimes have been stable over relatively long timeframes, allowing us to study long term responses temperature of adapted communities.

We measured annual secondary production in a subset of these streams across the temperature gradient. Macroinvertebrate communities were sampled approximately monthly, macroinvertebrates were separated from plant and detrital organic matter and inorganic matter, identified to the lowest taxonomic level, counted, measured, and their biomass estimated. Growth rates were determined experimentally and empirically by measurements of biomass change over time across a range or temperature by repeated photography of individuals, through changes in size frequency of populations over time, and through temperature-mass production relationships from previous studies within these systems.