

NCCRLN PROJECT TITLE: Snow, water, and forests: monitoring phenology and climate change impacts in mountain ecosystems of the National Parks of the Pacific Northwest

Ecosystems PROJECT LEAD:

Dr. Jeremy S. Littell
Research Scientist
CSES Climate Impacts Group
University of Washington
Seattle, WA 98195-5672
206-819-0876 (cell) / 206-221-2997 (office)
jlittell@u.washington.edu

PARK LIASON:

Regina Rochefort, Ph.D., Science Advisor, North Cascades National Park 360-856-5700 x254

Findings

We proposed to work with undergraduate students to develop: (1) a baseline monitoring network of snowpack and ecosystem phenology, and (2) guidelines for future monitoring and interpretation efforts

Forest phenology findings

The climatic determinants of budset and budburst (temperature, snowdepth, chilling etc.) vary with elevation, aspect, and slope position (e.g., convexities, concavities at local scales of tens of meters and topographic features that facilitate cold air pooling at larger scales of hundreds to thousands of meters). We chose locations for paired conifer budburst and temperature microsensor observations based on (1) accessibility of multiple forest zones along a gradient of factors likely to influence budburst and (2) proximity to universities (UW and WWU) attended by observers. In spring (late-April to early July) 2008, we conducted budburst observations near Mount Baker ski area (at 7 sites from about 650m elevation to about 1550m elevation) and at Paradise, Mount Rainier (at 5 sites from about 650m to about 2000m elevation). The consistency of observation was affected by the number of volunteers (some weeks no observations were conducted), but the information gathered was sufficient to conclude that (1) budburst is highly spatially variable for the same species and does not occur simultaneously regionally and (2) snowdepth is not the proximate limiting factor.

Budburst varied between Mount Baker and Paradise for the same species at similar locations, and within sites between individuals of the same species. For example, Pacific silver fir and mountain hemlock buds burst at Mount Baker (complete at 1300m and patchy at 1500m), likely around May 15, 2008, but were still tightly closed at Mount Rainier until at least two weeks later. Budburst in silver fir and mountain hemlock at Mount Baker occurred with several feet of snow

still on the ground around the trees with verified budburst, suggesting snowpack duration is not a good proxy for budburst at least for these higher elevation species.

We also conducted a brief survey at Colonial Creek, North Cascades, and budburst for western hemlock and Douglas fir at ~400m was around May 31, 2008.

These observations indicate that there is significant regional and local variability in budburst,

Recent research (Bailey and Harrington 2007, Peter and Harrington, in review) indicates a non-linear relationship between budburst and seasonal heat sums and chilling requirements.

Essentially, budburst is driven by the accumulation of heat energy over spring, and more total heat leads to earlier budburst to a point, after which budburst becomes later as limitations on chilling requirements affect physiology in different ways. Therefore, understanding budburst (or any phenological response related to climate) likely first involves a better understanding of variation in the physical environment of tree canopies, including temperature, solar radiation, and cloudiness during spring.

Future guidelines for monitoring and interpretation are as follows:

- Budburst is highly spatially and temporally variable within a year as well as within and between species: monitoring efforts should include budburst observations both across the season and in areas of both cold air pooling and areas of high solar loading
- Snowpack does not appear to be the most important limiting factor for budburst – independent research indicates canopy/atmosphere interactions are more important.
- If phenological monitoring became a priority for USNPS, budburst is one variable that could have strong responses to climate change, but which also might have more than one controlling variable affected by climate change. Trends in budburst may therefore be noisier than other phenological or ecological responses more closely tied to temperature or snowpack alone. For example, the establishment of seedlings in the alpine treeline ecotone is likely closely tied to these factors and is easier to monitor than budburst over complex terrain.

Extension

Observations made during this work indicated strong patterning in seedling establishment near treelines of the Cascades. These patterns qualitatively appeared to be related both to shading in summer and to the persistence of snowpack in the alpine treeline ecotone. To quantify these relationships in 2008-2009, we monitored snowpack persistence, summer shading, and air temperature in a subalpine larch, subalpine fir, and Engelmann spruce treeline at Harts Pass, near North Cascades National Park. In 2009-2010, we are conducting a similar set of observations at a wetter, cooler treeline (subalpine fir, Engelmann spruce, mountain hemlock) at Spray Park in Mount Rainier National Park. The data from Harts Pass is in analysis and will be submitted in winter 2010.

Bailey, JD, and CA Harrington. 2007. Temperature regulation of bud-burst phenology within and among years in a young Douglas-fir (*Pseudotsuga menziesii*) plantation in western Washington, USA. *TREE PHYSIOLOGY* 26: 421-430.