For everything there is a season – but the seasons, they are a'changing: Phenology shifts in the Tetons

Summary Report, January 2017

Background: The timing of many ecological events (phenology) – such as when plants flower or leaf out, or when insects emerge – is often closely linked to temperatures. As the climate continues to warm, many ecological events are occurring at different times than they did in the past. This is often the first sign that climate change is impacting natural populations, and may be an early warning of future population declines or even local extinctions. It is important to understand how a warming climate is impacting the timing of ecological events and how the effects of changes in timing may be rippling through the whole ecosystem to impact the many species that depend on plants in various ways.

The Project: In the 1970s and 80s, noted ecologist Frank Craighead, Jr. collected numerous observations on plant flowering times in Grand Teton National Park, in order to write the book *For Everything There is a Season* (now sold as *A Naturalist's Guide to Grand Teton and Yellowstone National Parks*). In the first year of the study (2015) we located his original data, entered it into a digital form, and demonstrated that it was usable data and that many plant species are highly sensitive to temperature changes in the Tetons.

Figure 1. Many charismatic flowers such as (clockwise from top left) sticky geranium, heart-leaf arnica, blue flax, and arrowleaf balsamroot, are likely flowering much earlier than they were in the 1970s.

In our second year of the project (2016), our goal was to lay the groundwork for collecting contemporary field data to compare with Craighead's data, which was collected before the impacts of climate change had started to be seen. In the 2016 field season, we retraced Craighead's steps, visiting sites on and around Blacktail Butte 15 times between April and August 2016. We focused in on several locations we thought Craighead was likely to have visited. On each field trip, we searched for flowering plants, identified flowering species and their phenological stage (newly emerged, newly flowering, peak of flowering, past peak, senescent, fruiting). We took GPS coordinates of patches of flowering plants and photographed plants. Because our field visits were frequent, we were able to identify early flowering patches of many species.

Through this process, we identified a set of 72 species that would be excellent candidates for a full research program that compares past with present phenology, with an eventual goal of modeling future phenology changes under a warming climate. Of these, we identified 23 species that would be excellent candidates for citizen science data collection (species that are easy to identify, common, and charismatic). We are preparing a simple set of instructions for citizen scientists to collect data on these species and submit them directly to the Nature's Notebook program of the National Phenology Network. Citizen science programs like this are an excellent way to engage students and other interested citizens in real data collection and in learning first-hand about how climate change is impacting their backyard.

Next Steps: In the next phase of the project, we will begin collecting contemporary data and testing out protocols and resources with citizen scientist volunteers.