The Effects of Accelerated Snowmelt on Pollination Networks and Pollination-Based Plant Reproduction
Lester Grant Proposal
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Introduction and Project Significance
The decline of pollinators, combined with changing seasonal environments, is one of the largest current global environmental concerns. Pollinators are important both for support of natural ecosystems and human agricultural production. Without them, it is possible that a third of our food supply would be gone, and many natural systems would collapse. Thus, it is important to gain a thorough understanding of how pollination systems could be impacted by the effects of changing climates. One way in which these systems can be impacted is through changed timing (phenology) of pollinator emergence and plant flowering, altered due to changing environmental cues. An important timing factor in many ecosystems is snowmelt, which contributes to when plants and pollinators emerge. With potentially warming climates, it is likely that snowmelt will occur earlier. It is the objective of this experiment to determine how accelerated snowmelt impacts species interaction and the structure and function of pollination networks.

Pollination networks – a type of mutualistic network – signify the interactions that form a link between two groups: plants and pollinators. These networks display a two level trophic system, which is relatively simplistic, and which enables structural characterization and experimentation. Also, ecological function – pollen-limited seed production – in pollination systems is relatively straightforward to examine. Even in the face of scientific interest and attention, there remains an insufficient understanding of the structural and functional response of species interaction to a phenologic disturbance (such as snowmelt). Thus, this proposal can fill an important gap in our understanding of these interactions.

Generally, experiments manipulating networks are minimal in terrestrial ecosystems. This is particularly true for mutualistic networks (Ings et al. 2009). Of these studies, almost all have focused on manipulations of either trophic diversity or number of trophic levels (reviewed in Borer et al. 2005; Duffy et al. 2007), instead of network response to disturbance as proposed here. This project’s focus on phenological mismatch follows calls to examine the effects of climate-driven species interaction changes on ecological outcomes (Blois et al. 2013; HilleRisLambers et al. 2013; Alexander et al. 2015). Growing literature on how phenological responses are altered by anthropogenic environmental changes has shown that these changes can lead to temporally shuffled interactions (Forrest & Miller-Rushing 2010). In this vein I concentrate on timing driven species interaction mismatch for my proposal. There have been a small number of excellent studies on plant-pollinator interactions in this area (Forrest & Thomson 2011; Parsche et al. 2011; Rafferty & Ives 2011), including small snow-melt manipulations (Gezon et al. 2016), though these focus only on one to a few pollinator or plant species. To the best of my knowledge there have been no experimental manipulation studies looking at an entire trophic level (i.e. all plants in a community) as is proposed here.

Even with repeated calls for an increased understanding of the relation between ecological function and network structure (Borer et al. 2005; Duffy et al. 2007; Ings et al. 2009; Thompson et al. 2012), as well as landmark experiments over 50 years ago (Paine 1966), recently little research has been completed to this end, particularly in terrestrial ecosystems. Thus, this
The proposed study will contribute to scientific understanding by examining how disrupted phenological mismatch in pollination networks impacts network structure and seed production.

**Research Question**
How will altered phenology of plant/pollinator interaction affect pollination network structure and seed production, the functional outcome of pollination interaction?

**Hypothesis/Prediction**
I predict that accelerated snowmelt relative to control plots will show altered pollination network structure and reduced seed production due to pollen limitation.

**Methods**

**Sites:** I will work in eight sites located at the Rocky Mountain Biological Laboratory. Each site is separated by at least 1km and each is comprised of two 10 x 15m plots, one control and one manipulated separated by ~100m. Each plot will contain three 1 x 10 m transects for observation, with 2m separating each transect. Snowmelt will be accelerated by staking 50% black shade cloth over snow covered plots approximately 5-6 weeks before the melt date. This method accelerates snow melt by about 2-3 weeks. All sites are similar in most aspects including elevation, temperature, and plant and pollinator communities. Dr. Brosi and other field team members will be utilizing the same sites to look at other pollination network questions.

**Data Collection:** I and other field team members will collect data weekly at each site. We will count the number of flowers in bloom in plant focused transects for each plant species to determine plant abundances. To record plant-pollinator interactions, we will observe all flower visits by pollinators in every 2m x 1m transect section for 3 minutes. This will be split into 90 seconds of observation from each side of the transect. Pollinators will be classified into one of 30 categories that have been successfully used by Dr. Brosi’s field teams at RMBL in the past. Seed production will be assessed by randomly selecting buds before flowering and collecting seeds.
when mature. These will be compared between specific species between control and manipulated plots.

Data Analysis: Data from each week will be analyzed using well-established ecological null models which Dr. Brosi has extensive experience using. Seed production and fruit abortion data will be analyzed using binomial-errors generalized linear mixing effects models previously used by the Brosi Lab (Brosi & Briggs 2013). The statistical program R will be used for most data analysis.

This project does not require IRB approval.

Project Resources
RMBL provides extensive resources including lab and field space and equipment. Dr. Brosi will provide all research equipment as well as local transportation. Dr. Brosi and our field team (including two graduate students, Connor Morozumi and Loy Xingwen) will be very helpful resources in the data collection and analysis. Several other researchers at RMBL focus on pollination biology and will be valuable resources for this project. Full or partial funding is requested to cover my flight, station fee, and housing.

Time Frame
My work at the Rocky Mountain Biological Laboratory will start June 12th and continue through August 13th. Data will be collected throughout the summer. The first week will focus on planning and setting up sites as well as reviewing methods. Our typical week will include data collection and analysis Monday – Saturday, with two sites sampled per day (ex. Monday sampling will include control and manipulation site 1 and 2). The goal will be to sample each site at least 7 times, weather and other circumstances permitting. The final two weeks at RBML will include final sampling and data submission.

Form of Final Project
At the conclusion of the summer field season, I will be using the work put towards this proposal to contribute to my honors thesis, which will be written with Dr. Brosi over the course of the 2018-2019 academic year.

References Cited


