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Collaborative Research: L TREB: Predicting the success of montane species in an era of climatic upheaval

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Data Management Plan

1. Data collected

The proposed research will produce the following types of ecological data: (1) observations of adults, (2) densities of nectar plants, and (3) caterpillar microhabitat conditions with natural enemy associations, with details by data type as follows.

(1) **Observations of adults** derive from our standard monitoring walks at five sites, and include presence and absence records (core data), annotations by abundance categories (indicating if adults are present as single individuals or as two or more individuals), and annotation by habitat types. Observations are recorded on datasheets that list all species by site and by habitat.

(2) **Densities of nectar plants** are recorded from randomly placed meter-square quadrats at intervals along our monitoring walks (by a different observer than the person making adult observations). Densities are recorded as percent cover of flowering stems by species within quadrats; data also include counts of individual butterfly species nectaring on specific plant species (with species identity of both plant and butterfly recorded).

(3) **Caterpillar microhabitat conditions and natural enemy association** data are multifaceted and include both observations taken directly in the field and data that accrue from lab-reared caterpillars and iButton readings. Field data are counts of predators by functional groups (e.g., coccinellid beetles, coccinellid larvae, chrysopid adults, etc.) in set areas adjacent to caterpillar plots. Data from caterpillar plots include percent cover by plant species (taken in the field) and the density and identity of caterpillars reared from individual plots (these records accrue from lab rearings and are linked to field plot data by unique numbers) as well as the abundance and identity of parasitoids that emerge from caterpillars. Following work that the Dyer lab has done for many years with field-collected caterpillars, we will use tentative morphospecies names of caterpillars and photos during development to link species identifications (based on adults) to specimens even if killed by emerging parasitoids. Data from iButtons sensors will be downloaded with a field laptop twice per year.

2. Data storage and preservation

We take all field observations and measurements onto hardcopies of datasheets. At the end of each field day, we use cell phone cameras to make quick backups of sheets which are emailed from phones to a central lab address; hardcopies are then used to digitize data into spreadsheets (using Google Sheets and a lab gmail account). The Google Sheets are then our working repository from which data can be downloaded for ongoing analyses; once per month, the online spreadsheets are saved as plain text csv files to our UNR cloud storage (Box) account. The adult observations (core data) will also be entered every two weeks onto our public-facing website that will be created as part of the LTREB work (featuring forecasts as well as empirical returns from the field). The only exception to hardcopy records from the field are temperature data: the field laptop used to retrieve iButton data will sync with the Box account as soon as it is on campus. All data of all types will be (at least once per month) transferred to the Gompert lab for use in analyses and for secondary backup. Gompert will store these data on central computer servers with RAID arrays at the University of Utah Center for High Performance Computing (CHPC). Gompert has 80 TB of dedicated storage space on this cluster.

3. Dissemination methods and policies for data sharing

Our core data (presence and absence of butterflies) will be made immediately available to the public through a UNR hosted website (Forister has previously facilitated public access to data through butterfly.ucdavis.edu). Scientists, butterfly enthusiasts and any other member of the public will be able to

download data in formats that include spreadsheets and csv files for individual sites, species, or for all sites and species combined. In addition to raw data, we will have a report-generating function that will take the scientific or common name of a butterfly and produce a downloadable one-page PDF with a graph of phenology by site as well trends over time and synopsis of our archived natural history data (host plants used, number of generations per year, etc.). We have been experimenting with a prototype of one element of this report (sites.google.com/view/westernbutterflies/data) and have had positive feedback from amateur lepidopterists. Finally, we will contact relevant amateur and professional groups with a notification and description of these resources (e.g., The Lepidopterists' Society, The North American Butterfly Association, as well as native plant and birdwatching groups).

Other data types (e.g., caterpillar microhabitat temperatures or parasitoids from field-collected caterpillars) will be made available through Dryad and other repositories at the time of publication of relevant papers. Any data not published by the end of the initial, five-year grant period (June 2026), will be made available at that time. The metadata in these repositories will contain all of the information needed for other scientists to reuse these data and recreate our analyses of them.

Our commitment to free and open exchange in science extends beyond data sharing. Computer software and scripts developed as part of this project will be made freely (i.e. open-source and no monetary fee) available to academic and non-academic users under the GNU General Public License v2. This ensures that the programs and their source code will be available to all to use, modify and reuse so long as they grant the same rights to others. Code will be maintained and documented on GitHub, and all of our repositories related to the project will be made public. Manuals and examples will be provided with the software. We will also prioritize publishing papers from this project in open access journals or those that have an open access option.