Priorities for Year 1 NWT LTER VII

Selection criteria for funding includes the degree to which the work supports the goals and research activities in the NWT VII grant, particularly activities outlined in the proposal that are not currently supported in other ways or which may not be achieved without additional support. Below is a list of topics that relate to the NWT VII research activities found in the proposal. Asterisks indicate activities with particularly **high priority** to start in Year 1.

Please see the complete RFP for application information on format, funding criteria, and deadlines (http://niwot.colorado.edu/rfp/). We also list example postdoctoral synthesis projects here (http://niwot.colorado.edu/postdoc/); these are indicated by a [P] but can also be proposed as a GRA.

Hypothesis 1 (Shifting Limitations)

*Preliminary work to identify sites for the growing season length experiment and collect pre-manipulation baseline data prior to initiating the black sand treatments to speed snowmelt on May 2018. Our proposed design is to stratify by habitat type, with six experimental sites located in each of the following habitats: subalpine forest, open canopy treeline, dry meadow tundra, moist meadow tundra, snowbed tundra, and unvegetated talus (for a total of 36 experimental sites).

*Initiate and develop protocols for long-term monitoring of soil and plant processes in select tundra and forest permanent plots (e.g. NPP, nutrient cycling, soil moisture, microbial biomass and enzyme activities), with the overall goal to allow us to better integrate biogeochemical processes with our other long-term monitoring.

Extend biogeochemical model of limitations/predictions of productivity to alpine lakes. Create a model in parallel to the tundra model that uses stoichiometric and physical constraints to phytoplankton growth with a mechanistic biogeochemical model based on the initial modelling work by Miller et al (2009) integrated with the framework of Fan et al 2016. [P]

*Increase our understanding of how functional responses may translate into compositional shifts in tundra and lakes. For instance, for plants, quantify a suite of traits for species across the alpine tundra that are indicative of this spectrum of functional strategies such as leaf carbon isotope composition ($\delta 13C$), specific leaf area, and leaf chlorophyll content. This information could be used to develop algorithms to simulate growth, C allocation, respiration, and resource assimilation, and extend predictions of how climate may affect resource and physical limitations (e.g., Fan et al 2016). This information could also be used to better assess trade-offs within populations and across species related to H3 (towards community-level compensation efforts and possibly demographic trade-offs, local adaptation).

Generate baseline data and/or perform pilot manipulations in preparation for the lake GSL experiment, which aims to manipulate both DOC and water residence time. To match manipulations conducted in the terrestrial environment, we will use experimental limnocorrals (or smaller mesocosm approaches?) in Lake Albion (subalpine) and Green Lake 4 (alpine) to evaluate the effects of changes in flushing rate and water residence time. Timeline: pilot work could be done in year 1 or 2, with full experiment to start in year 2 or 3.

Determine long-term shifts in habitat distribution of pika populations/occupancy. Extend our monitoring efforts of pikas from the west knoll to lower-elevation protected sites in the Green Lakes Valley.

Hypothesis 2 (Biotic Effects)

*In hypothesis 2, we proposed to manipulate biotic interactions by focusing on how physical protection from wind can lead to facilitative effects. We can manipulate these effects by planting foundational species as well as construct artificial wind barriers that simulate the presence of foundation individuals. Year 1 would be a time to conduct preliminary tests of these methods and develop a protocol for the experimental work planned for summer 2018 in conjunction with the growing season length manipulations.

For the corresponding lake-related research, conduct pilot studies or manipulations of dissolved organic carbon/matter (DOC/DOM, related to lake experiment work manipulating residence time, above), hydrochemistry long-term data, or other relevant components. Changes in land cover due to uphill tree-, shrub- and tundra advances are expected to increase terrestrial DOM subsidies in lakes. We proposed to mimic this phenomenon within the limnocorral experiment described previously by adding highly concentrated DOM to experimentally determine the effects of terrestrial DOM subsidies on phytoplankton and zooplankton communities. Work in year 1 or 2 to develop methods and protocols for these manipulations would allow the full experiment to start in year 2 or 3.

Develop quantitative methods to use long-term observations to describe positive and negative associations among species. Use repeated measures of population growth rates or abundance over time to estimate population dynamics in a simple competition model that can take into account effects of other species or functional groups, effects of focal species density or frequency, as well as effects of climate or environmental parameters such as snowpack. The approach could be used to better understand the indirect effects of climate through modification of species interactions.

Hypothesis 3 (Compensation)

*Develop protocols and initiate measurements to expand our treatment of demography and primary production to forests. We proposed to focus on *Abies lasiocarpa* and *Picea engelmannii*, include four forest stands to extend forest sampling to treeline, and initiate forest production estimates comparable with our long-term tundra production estimates.

*Investigate compensatory dynamics in lakes. Work could involve completing identification of the zooplankton and phytoplankton communities in samples collected in the 2016 as part of a comparative lake sampling across 15 lakes. It could also involve examining long term compositional records in GL4 to assess portfolio effects across depth within a single lake.

*Better understand spatial variation at the landscape scale, and whether spatial variability in the timing of a process such as productivity can stabilize function at the landscape scale. Work could involve efforts to understand the phenology and timing of greenness and relationship to production by establishing phenocam-like cameras to quantify greenness at measurement nodes in the saddle catchment.

Identify water versus energy limitation at larger spatial scales using remote sensing, linking these measurements with empirical measurements. Work could involve deriving NDVI from the Landsat satellite time series (e.g. Landsat 5 – 8) to examine correlations between NDVI and snowmelt versus correlations between NDVI and PET, and supervised classification methods to identify habitat types [P]

Link responses at the demographic, community and landscape levels of ecological organization by quantifying compensatory dynamics or portfolio effects. Work could include assessing buffering effects over time as well as over space. Long-term data in alpine tundra and lakes can be used to estimate portfolio effects of key species, across communities and at the landscape scale. [P]

Hypothesis 4 (Catchment Integration)

*Better understand hydrological flowpaths in the saddle catchment. Work could include using DHSVM with dynamic inputs (meteorology) and static fields (topography, soils, vegetation) and validating model soil moisture, streamflow, and fluxes to local observations. Preliminary simulations could identify locations of high and low connectivity. These end member locations will guide field deployment of tracer analysis (in later years).

*Complete basic nutrient cycling and soil characterization work in the saddle catchment. Select saddle grid and forest stand plots, three times annually (n=20 sites, 60 samples/measure/yr). Nested sets of lysimeters (at each habitat type, multiple depths) to measure soil water fluxes and chemistry. One-time soil characterization.

Characterize saddle catchment heterogeneity using winter and early spring sensor data (snow depth, temp, melt out, soil moisture). Work could include validation of the Fan et al. (2016) model/CLM across community types, and the use of sensor network data for parameterization.

Incorporate hydrological connectivity into biogeochemical model of stoichiometric and physical constraints of tundra productivity. The framework developed by Fan et al (2016) does not incorporate fluxes of water and nutrients, although this spatial connectivity is a critical component of ecological responses and catchment export of water and nutrients. Gridded landscape simulations may be one way to incorporate biogeochemical processes (as in Fan et al 2016) into a hydrological model such as DVHM. [P]

Climate Group

Complete quality controls on C1 and D1 climate data. Ensure dataset is of high quality and usable to NWT researchers. Institute a three-tiered data delivery system.