

INFORMATION ON THE MONITORING COOPERATIVE APPLICATION

THIS IS AN APPLICATION TO BE INVOLVED IN THE VERMONT MONITORING COOPERATIVE'S (VMC) MONITORING AND RESEARCH NETWORK AT MOUNT MANSFIELD. IN ADDITION, IT IS THE APPROVAL PROCESS NEEDED TO CONDUCT MONITORING OR RESEARCH ON STATE LANDS AT THIS SITE.

GOALS OF THE VERMONT MONITORING COOPERATIVE

Improve our understanding of the conditions, trends and relationships in the physical, chemical and biological components of the forested ecosystems in Vermont.

Facilitate the efficient coordination of multi-disciplinary environmental monitoring and research activities among program participants.

APPROVAL PROCESS

In providing a well coordinated and integrated monitoring and research program at the Mansfield site, we are requiring all participants **to apply to the VMC annually**, for project approval and location permission. Project approval is to ensure that the proposed project's goals and objectives are in keeping with those of the VMC, to prevent duplication of efforts, and to maintain good communications on all new and changing activities from year to year. Location approval allows each cooperator to function without the threat of interference from others, allows the VMC to ensure that land use is in keeping with VMC guidelines, and provides needed information on specific locations of projects to update our GIS information.

The requirements for VMC application approval are:

1. the project is in keeping with the goals and objectives stated above,
2. adequate project information is provided to understand the proposed project,
3. the cooperator agrees to provide data or results to VMC in a timely manner,
4. and the applicant agrees to provide an annual progress report or information for an annual VMC report.

In addition, we encourage VMC cooperators to facilitate the flow of information on forested ecosystems through cooperation with other members, and participation in any VMC information exchange meetings.

The application process is meant to be simple, quick, yet informative, and is as follows.

Complete the application, sign and date it, and return to the VMC Program Coordinator, Carl Waite (contact information below).

Your application (new projects) will be reviewed by the VMC Program Coordinator and may also be reviewed and commented on by the VMC Advisory Committee. If the project is approved, the Program Coordinator will sign your application and forward it to the Vermont Department of Forests, Parks and Recreation for location approval. This process can be completed at any time, preferably well ahead of the field season.

Location approval, which is granted by the Vermont Department of Forests, Parks and Recreation, can be postponed until the field season to allow for on-site verification of a suitable location. If the applicant needs more information on potential sites for project implementation, list criteria needed on the application (number 4), and the Program Coordinator will assist you in locating an appropriate site.

In addition, the Program Coordinator will set up a site visit for new cooperators, to assist in locating appropriate study sites, and to familiarize the cooperator with other VMC activities. Allow 2-3 weeks for your application approval.

OTHER PERMITS

This approval covers activities conducted on State owned lands at the site. Other landowners that you may need to contact are:

- * Rick Paradis, Director of the University of Vermont Natural Area (660 feet on either side of the summit) (802-656-4055),
- * Tim Perkins, Director of the Proctor Maple Research Center (802-899-9926),
- * Manager of the Mt. Mansfield Company in charge of the east slope Toll Road access, and
- * Private landowners at lower elevations on both sides of the mountain.

Collection or disruption of federally listed threatened or endangered plant or animal species requires a permit from the U.S. Fish and Wildlife Service. Contact Laurie Eaton at 802-951-6313.

Collection or disruption of state listed threatened or endangered plant or animal species requires a permit from the Vermont Natural Heritage Information Program. Contact Steve Parren at 802-241-3717.

Collection of any vertebrate species requires a Scientific Collecting Permit from the Vermont Department of Fish and Wildlife.

Any University of Vermont researcher conducting studies involving vertebrate animals must receive approval by the University of Vermont Institutional Animal Care and Use Committee. Contact Penni Cross (Penni.Cross@uvm.edu) at 802-656-5040.

Any environmental manipulations (constructions, major cutting of the forest, additions of fertilizer, etc.) especially above a 2300 foot elevation may require more extensive review and approvals, such as approval by local town authorities or Act 250 reviewers.

VMC Program Coordinator: Carl Waite
University of Vermont
George D. Aiken Forestry Sciences Laboratory
705 Spear Street
South Burlington, VT 05403
(802)-656-0683
carl.waite@uvm.edu

GUIDE TO PLOT LOCATION AND MARKING

State Land on Mount Mansfield is managed for multiple uses. Establishment of plots or study areas must be sensitive to the fact that recreation and aesthetics are two major uses of this mountain.

Guidelines:

1. When establishing permanent plots or study areas off recreational trails, please locate your plots at least 100 feet from the trail. Periodically trails are relocated to avoid erosion, and this distance should prevent conflict between trails and plots. Plus, any markers you use on your plots will not be as visible to recreation users from this distance.
2. Avoid the overuse of flagging. While it is important to mark your study area for relocating and to avoid others using the same spot, too much flagging in the woods can become a problem. Try to be sensitive to this.
3. Permanent markers can consist of a PVC pipe at plot center, aluminum tags on tree butts, or other non-corrosive items. Please clearly label all markers, and where abbreviations are used, send a list of these to the VMC Program Coordinator for permanent documentation.
4. If you frequently visit your study area and are creating "research trails" that hikers may see and wander onto, please place brush or other natural obstructions at the start of your trail to avoid any unwanted entry. This is for your protection and to prevent hikers from being confused about which trail they should be on.
5. On the west slope of the mountain, the Brown's River watershed (which includes the land above the Underhill State Park) has been designated as an undisturbed area (no cutting will occur other than hazardous trees). The Stevensville Brook watershed (surrounds the Butler Lodge Trail) will undergo silvicultural treatments periodically. On the east slope of the mountain, in the Ranch Brook watershed, the south portion of the watershed is designated as an undisturbed area, and the north portion will periodically undergo silvicultural treatments for research purposes (request a map if you would like to know the boundaries). Keep this in mind when choosing which watershed to locate in.

VERMONT MONITORING COOPERATIVE APPLICATION

FOR MONITORING AND/OR RESEARCH ON MT. MANSFIELD

Applicant's Name: Dr. Stephen Keller (Principal Investigator)

Ms. Brittany Verrico (Graduate Student)

Applicant's Address: Department of Plant Biology

111 Jeffords Hall

63 Carrigan Drive

University of Vermont

Burlington, VT 05405

Email Address: srkeller@uvm.edu, bverrico@uvm.edu Telephone No: 802-656-5121

Organization/Affiliation: University of Vermont, Plant Biology Department

Project Title_ Genomic analysis of climate change responses in northeastern red spruce forests

1. Describe your project, including: purpose, details of study area size, number of samples and parameters to be taken, any alterations made to the site, study area markings, structures or equipment to be installed. (This application may be accompanied by a more detailed project description of up to 2 pages in length.) We would like to include information on your activity in our annual VMC Monitoring Work Plan.

The proposed research activities for Mount Mansfield are in support of a grant from the USDA HATCH program to PI Stephen Keller. The primary research goal is to investigate the genetic diversity in red spruce (*Picea rubens* Sarg.) along elevation gradients in the Green Mountains in order to understand climate change impacts on (1) upslope migration and gene flow, and (2) local adaption in physiological traits sensitive to climate (e.g. tolerance to freezing injury).

Field collections to obtain spruce tissue for genetic analysis will take place during September 2015. Choice of sampling locations is being coordinated with A. Kosiba, P. Schaberg, G. Hawley's established plots in the Stevensville Brook or the Brown's River watershed, which were previously used by this group to investigate freezing injury to red spruce. The plots in the Stevensville Brook and Brown's River watersheds are located at three different elevations: low (451 and 628 m), medium (757 and 773 m) and high (927 and 910 m), respectively. Activities specific to Keller's permit involve sampling a small amount of needle tissue for DNA analysis from red spruce trees growing in the vicinity of the plots established by Kosiba et al. Sampled trees will be grouped according to elevation into 3 site categories: low elevation (<750 m), mid elevation (750–850 m), and high elevation (>850 m). The elevation groupings correspond to the approximate locations of the boreal-deciduous ecotone, as inferred from Beckage et al. (2008). Within a given elevation site, we will sample

needle tissue from two different stage classes of spruce trees to compare genetic diversity among different cohorts: established trees (>2 cm dbh, N=45 trees per elevation site) and regeneration seedlings (<2 cm dbh, N=45 trees per elevation site). Sampling consists of removing 2-3 inches from the end of a healthy spruce twig, and bringing the tissue back to Keller's lab at UVM for DNA analysis. Sampling is non-destructive and does not harm the trees. Keller has previously obtained permits to conduct this type of sampling in red spruce on both state (Camel's Hump and WV-DNR Canaan State Parks) and federal (USFS Monongahela National Forest) lands.

During tissue collection, mature cone-bearing trees (N=8 reproductive trees per elevation site) will be assessed for cone production. Specifically, we will collect cones after seed fill, but before full maturation and seed drop (as indicated in the Woody Plant Seed Manual). When it is possible to reach cones, we will collect up to 5 cones from each of the 8 reproductive trees sampled per elevation site (N=24 trees total). The remainder of the cones will be collected by John Butnor, a plant physiologist with the USDA Forest Service. Mr. Butnor will submit a separate permit application in support of his cone collecting activities. Cones will be brought back to Keller's lab and processed according to New Hampshire State Nursery practices. Namely, cones will be dried in mesh bags, seeds extracted by gentle shaking, and stratified at 4°C for 3 months. In January 2016, seeds will be germinated in 85mL Jiffy media and grown for six months at the UVM greenhouse before harvesting needle tissue.

Needles will be used to extract DNA and survey genetic diversity and relatedness between mature trees, understory regeneration, and new seeds to determine the extent of gene flow between elevations, and in conjunction with freeze damage tests on experimentally grown seedlings to determine the extent of cold-hardiness in red spruce originating from different elevation environments in Vermont.

2. What types of activities by other VMC cooperators would be incompatible on the area you are using (for example, observational data collection, management manipulations, stream alterations, etc.)?

Silvicultural practices occurring immediately before and during tissue and cone collection in September could negatively impact this study.

3. What is the anticipated duration of this project?

Tissue and cone collection will occur during September 2015.

4. Has a specific study area location(s) been identified, and if so, please indicate location(s) on an attached map (this also applies to existing projects). If study area location is not known at this time, what criteria will you use to select plots?

Sampling will occur in the vicinity of previously established elevation plots by Kosiba et al., in the Stevensville Brook and/or the Brown's River watersheds (Table 1). Our preference

is to sample the 3 plots in the Stevensville Brook watershed because there is additional data available from Kosiba et al. for these plots on historic winter injury levels in red spruce that would inform our analyses. However, as a contingency we could alternatively sample from the Brown's River watershed plots. Our decision will be based in part on whether there are current or ongoing silvicultural treatments in these areas, and would be aided by information from the VMC on recent silvicultural treatments in these watersheds.

Please see the attached map and table listed below detailing the plot sites.

Table 1. Location of proposed sampling plots for red spruce needle and cone collection.

Watershed	Elevation Zone	Elevation (m)	Latitude	Longitude
Stevensville Brook	low	451	44.50562	-72.84274
Stevensville Brook	medium	757	44.51026	-72.82603
Stevensville Brook	high	927	44.51605	-72.8206
Brown's River	low	628	44.52841	-72.83656
Brown's River	medium	773	44.53240	-72.82835
Brown's River	high	910	44.53185	-72.82291

5. List ways in which this project fits goals and objectives of the VMC.

The proposed research serves the mission of the Vermont Monitoring Cooperative as it investigates the consequences of current climate change for forested ecosystems in Vermont. Vermont's high altitude forests are sentinels of climate change, store considerable carbon, and are regionally important sources of recreation and biodiversity. Red spruce is a dominant component of these forests and has already been shown to be sensitive to effects of atmospheric acid deposition and climate warming. Specifically, this species has declined in abundance and shifted upslope in elevation as a response to anthropogenic influence. Physiological experiments have linked decline to winter injury, which occurs when mid-winter warming is followed by abrupt return of cold temperatures. Substantial loss of productivity and carbon sequestration results from this injury, and may increase in frequency with climate change. This research will investigate if red spruce contains the necessary genetic variance for cold tolerance to respond to selection by freeze events and how gene flow across elevation gradients will affect the capacity for local adaptation. The genomic data generated from this research are valuable resources for optimizing red spruce growth, conservation, and restoration. By addressing these concerns, we will have better insight into an ecologically and economically important tree species to Vermont.

6. When will your project data be available to VMC cooperators and others, and in what format will data be submitted to VMC?

The proposed research is at the beginning of a 3-year grant cycle and will continue until 2018. The locations of sampled trees can be available immediately after tissue and cone collection (Fall 2015). The genetic data and results from the gene flow analysis will form the basis of Brittany Verrico's Master's Thesis in the Keller Lab at the University of Vermont.

These data will be publically available following completion of Verrico's thesis, and can be made available to the VMC prior to publication upon request. Likewise, copies of any professional journal articles rising from this research can be provided to the VMC.



Brittany Verrico

Applicant's signature

August 11, 2015

Date

Terms of approval (if any):

Project approval:

Location approval:

VMC Official signature

FPR Official signature

Date

Date