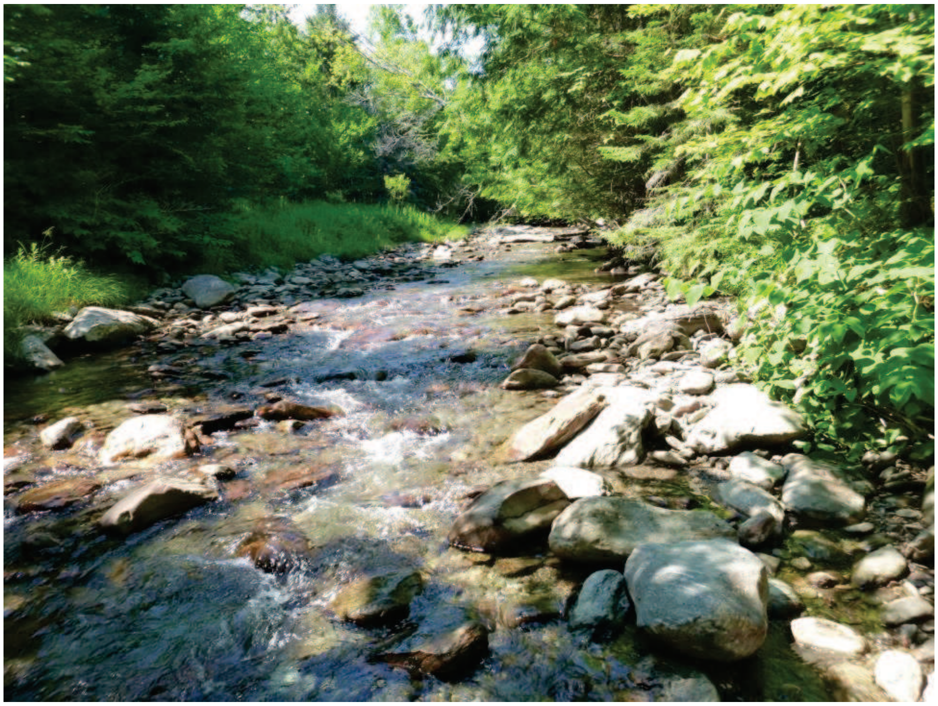
Proceedings of the December 02, 2016

Vermont Monitoring Cooperative Conference

Healthy Forests, Healthy Watersheds



Vermont Monitoring Cooperative

Davis Center • University of Vermont • Burlington, VT, USA

Vermont Monitoring Cooperative

Providing the information needed to understand, manage, and protect Vermont's forested ecosystems in a changing global environment.

Established in 1990 and ratified in 1996 via a memorandum of understanding between the Vermont Agency of Natural Resources, the University of Vermont, and USDA Forest Service, the Vermont Monitoring Cooperative (VMC) has been conducting and coordinating forest ecosystem monitoring efforts for twenty-six years.

Originally designed to better coordinate and conduct long-term natural resource monitoring and research within two intensive research sites (Mount Mansfield State Forest, the Lye Brook Wilderness Area of the Green Mountain National Forest), VMC efforts have since expanded to capture relevant forest ecosystem health work across the state of Vermont.

Today, Vermont Monitoring Cooperative funding stems primarily from a partnership with the USDA Forest Service State & Private Forestry as part of the Cooperative Lands Forest Health Management Program. The majority of VMC operations are handled by staff affiliated with the Rubenstein School of Environment and Natural Resources at the University of Vermont, the Vermont Department of Forests, Parks & Recreation in the Vermont Agency of Natural Resources, and the USDA Forest Service's Green Mountain National Forest. While VMC funding primarily supports ongoing research, monitoring, outreach and data management, the bulk of VMC activities are accomplished by "in kind" contributions provided by the larger collaborative network.

The current mission of the Vermont Monitoring Cooperative is to serve as a hub of forest ecosystem research and monitoring efforts across the region through improved understanding of long-term trends, annual conditions and interdisciplinary relationships of the physical, chemical and biological components of forested ecosystems. These proceedings highlight some of the VMC activities aligned with this mission and demonstrate the potential of large collaborative networks to coordinate and disseminate the information needed to understand, protect and manage the health of forested ecosystems within a changing global environment.

Online at http://www.uvm.edu/vmc

VMC Steering Committee and Advisory Committee – http://www.uvm.edu/vmc/about/committees

VMC staff – http://www.uvm.edu/vmc/about/staff

VERMONT AGENCY OF NATURAL RESOURCES

The University of Vermont

USDA FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

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Healthy Forests, Healthy Watersheds

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Introduction to the Proceedings

The Vermont Monitoring Cooperative's (VMC) annual conference was held on December 2, 2016 at the Davis Center on the University of Vermont campus. This marked the 26th year of coordinated Vermont Monitoring Cooperative activities. The guiding theme on "**Healthy Forests, Healthy Watersheds**" reviewed how forest management influences watershed conditions and responds to changes in those conditions.

The morning plenary session was led by three experts who addressed the current state of understanding about the links between forest management and watershed-level health. Each speaker gave focused, 15-minute talks exploring the relationship between watershed-level indicators of ecosystem condition and how forest management and planning is adapted in response to changes in these indicators. Our morning speakers brought to light the importance of an ecosystem approach to forest management as well as ensuring that an interdisciplinary team leads the management efforts. This team should include a diverse set of researchers, land managers, and citizens alike.

This year the afternoon was devoted to two concurrent sessions where 25 collaborators from across the region presented their most recent work, followed by six working group sessions on a wide range of topics that were offered by members of the Cooperative.

VMC to become the **Forest Ecosystem Monitoring Cooperative**!

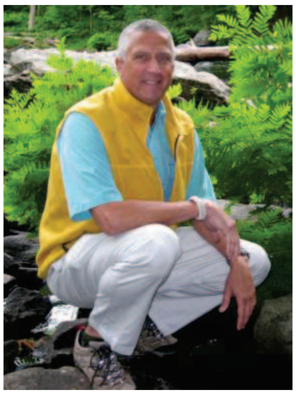
Recognizing the need to take a more regional approach to forest ecosystem monitoring, the VMC has been expanding its work and network to other states in the northern temperate forest region. Therefore, VMC will be changing its name in early 2017 to the **Forest Ecosystem Monitoring Cooperative** and welcoming new members to the Steering and Advisory Committees. Find more details at https://youtu.be/Ctj4eQZElc8

These proceedings represent a combination of summaries of the plenary session talks summarized by VMC staff, syntheses and products from a series of afternoon working sessions, and the abstracts submitted by researchers to the concurrent sessions. Additional details, including videos and downloadable PowerPoints of presentations can be found on the meeting home page at: www.uvm.edu/vmc/annualMeeting/2016/content.

Figure 1. Great blue heron flying over a marsh in Vergennes, Vermont.

Understanding the Links between Forest Management and Watershed-Level Health

This year's plenary focused on the links between forest management and watershed-level health. Three experts in the field, Karl Honkonen, from the USFS Northeastern Area State and Private Forestry, Toni Lyn Morelli, a USGS Research Ecologist from the Northeast Climate Science Center and Colin Beier, from the Department of Forestry and Natural Resource Management at SUNY College of Environmental Science and Forestry, explored the relationships between northeastern forests, their management and watershed-level indicators of ecosystem condition.



Karl Honkonen, a watershed forester who works directly with land managers and forestry practitioners across the northeast, focused on the use of riparian buffers to manage for improved water quality and downstream habitat. Surface water is an incredibly important resource in our region which needs to be managed carefully. The USFS's Northeastern Area comprises about 41% of the total population of the United States, many of whom depend on surface water supplies protected by forests. Keeping forests intact is the number one priority, but when development or agricultural practices encroach on surface waters, riparian buffers are essential to maintain water quality and wildlife habitat.

Surface water quality is directly related to the quality and management of the surrounding land. Water intercepted and filtered through forests results in the highest water quality because forests are most effective at removing pollutants and providing shade that helps lower water temperature. The biggest water pollutant issue in Vermont is phosphorus from agricultural runoff that makes its way to Lake Champlain where it drives algal blooms. Forest buffers have been shown to filter phosphorus and improve water quality better than grass or wetland buffers. In addition to removing phosphorus, forests also help remove nitrogen, sediment, organic matter and other pollutants. They absorb floodwater, slow down flow during high flow events, and create shade for aquatic organisms, especially cold water fish species.

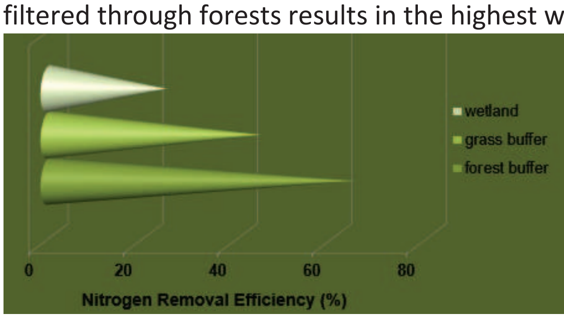


Figure 2. Nitrogen removal efficiency (%) between wetlands, grass buffers, and forest buffers.

Because it is unrealistic to manage all forests, our best tool for watershed health is to maintain a forested buffer around surface waters. Many programs require minimum 35-foot buffer for any sponsored project, however, a 100' buffer is ideal. While no one disputes the importance of riparian buffers, there is often conflict between maximizing buffer size at the cost of removing land from production or development use. To offset economic or land loss due to the creation of buffers there are landscape scale **restoration grants available from the USFS**. Similarly, reforesting suburban lawns to create forested buffers can be funded by the **USDA's Conservation Reserves Enhancement Program**. After re-establishing forested riparian buffers, these projects include monitoring and maintenance plans to ensure the buffer is fully restored and functioning. These are just two of many examples of funding mechanisms provided by multiple agencies partnering to restore riparian corridors.

Photo http://www.vtinvasives.org/plants/impact-invasives

Toni Lyn Morelli is a Research Ecologist who has spent the past several years examining how the threat of invasive plants may be changing under various scenarios of climate change. Dr. Morelli reviewed the evidence showing that climate is changing in the northeast and that these changes are expected to continue. Temperatures have increased significantly in the last two decades at a predictable rate but precipitation is "messier". Rather than a simple increase in the amount of precipitation, climate change is manifested in fewer, larger storms (flood events) punctuated by droughts, as well as a lengthening of the growing season on both ends.

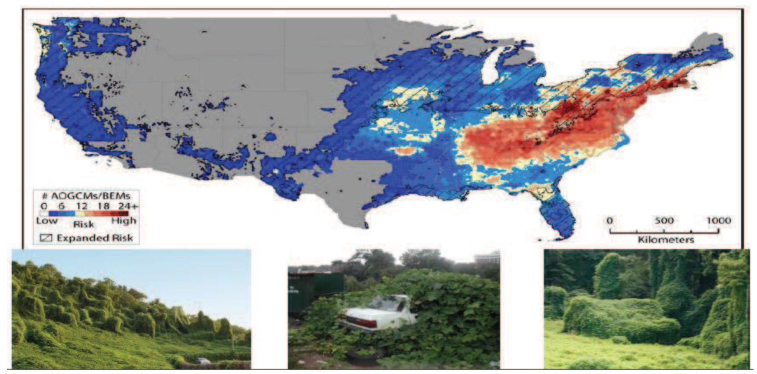


Figure 3. Projected kudzu invasion.

These changes have indirect effects on forest ecosystems through their impact on invasive species. While rising temperatures and altered precipitation patterns may not *directly* favor invasives, research shows that many invasive species green up earlier than natives and demonstrate increased plasticity, making them better able to adapt to changes than native species. Recent studies show that flowering time in invasive species shifts more easily in response to temperature. Barberry, garlic mustard, and knotweed are classic examples of this adaptive trait. Invasives are also easily dispersed by human activity and can more rapidly shift ranges with changing climate. Lacking the climate control of a cold winter may expand pest ranges as well, as seen with the invasive southern pine beetle, emerald ash borer and hemlock wooly adelgid.

"Hot spots" for plant invasions are also related to climate envelopes. A recent study reports that the northeast is a particularly vulnerable hotspot for future plant invasion. This is compounded by increased disturbance events that favor invasive species with rapid, aggressive growth allowing them to quickly exploit areas where the forest canopy is opened. All of this is further exacerbated by increased atmospheric carbon dioxide, which favors increased growth and resistance to herbicides in many invasive species.

In response to this increasing threat of invasives, the **North East RISCC** (**Regional Invasive Species and Climate Change**) **Management Network** was created. This group of scientists and invasive species managers work to summarize the latest research, synthesize the current knowledge around invasives and climate change, and identify ongoing monitoring needs. This group is also working to identify management strategies, establish demonstration plots, creating a watch list of species likely to become invasive in a future climate, actively managing to limit pathways of invasions and targeting management in areas vulnerable to extreme weather events. Next steps are to form a formal working group with an expert advisory board and a listserv to coordinate regional activities. To join the listserv and stay abreast of the latest RISCC activities email: ne_riscc_1@cornell.edu

Colin Beier, a systems ecologist, considers forests as a social-ecological system that provides many services to human communities. Dr. Beier spoke about the importance of monitoring data to measure how forest management, land use change, pollution, and other factors synergistically impact the multiple benefits provided by northern forests. Such data is essential to understanding how landscapes respond to various drivers of change. Long-term monitoring is particularly important as it captures ecosystem dynamics over time and can provide a basis for inferring the drivers of these responses.

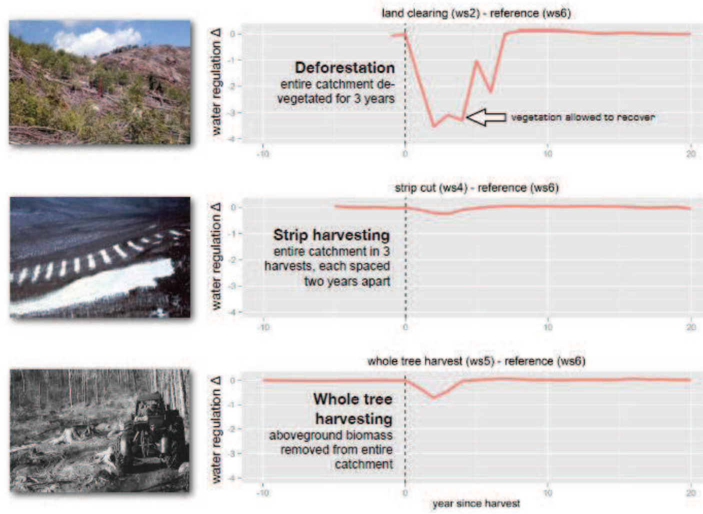


Figure 4. Deforestation vs. management, integrated impacts on water regulation benefits.

Data collection and analysis is important but the translation of these findings is equally important. This involves using an interdisciplinary approach to thinking about the forests *and* the ecosystem services that forests provide. Measuring ecosystem services provides accounting for cost benefits to help inform management decisions and provides evidence to policy makers for the value of healthy forests. This goes beyond just putting a dollar value on nature, as non-monetary assessments are also important.

The **Forest Ecosystem Services Toolkit (FEST)** is a set of tools designed to assess these varied ecosystem services (clean water, flood mitigation, removal of greenhouse gasses). FEST draws on "big data"- many long-term data sets and open source geodatabases with web based data visualization to assess these services. Using multiple and varied long-term data sets it is possible to develop key indicators relevant to a given benefit and identify the "Goldilocks Zone", where forest ecosystem and human needs are balanced.

As an example, Dr. Beier and his colleagues have used long-term hydrology records to identify the functional loads on systems, and show how those systems regulate themselves and identify various benefits, such as climate impact or pollution removal. Changing parameters can be used to analyze how flood control or drought mitigation might respond under various management regimes. Their work shows that when we manage forests well, the impacts to water flow are minimal and impacts on pollutant removal and climate regulation may remain unimpaired.

Another example uses air quality and stocking records gathered by the Adirondack Lake Survey Corporation of the Adirondacks to assess the economic benefits of improved fish habitat. With improved pH after emissions standards were mandated, better fishing brought more economic activity to the region. This type of analysis can also identify the best timing for fish stocking.

It is critical to maintain our ecosystems and to fight to keep Clean Air standards and emissions caps. Having a toolkit to analyze and translate the value of heathy ecosystems is particularly timely.

Take Away

The panel discussion, moderated by Dan Lambert of High Branch Conservation Services, highlighted success stories. Karl Honkonen stated that the greatest successes he has seen have come through sound forestry practices. He stressed the importance of implementing best practices for harvest activities because forestry has a Clean Water Act exemption as long as Acceptable Management Practices are in place. Educating loggers has been important to minimize impacts, resulting in eighty to ninety percent of all monitored logging jobs with no noticeable impacts.

Tony Lyn Morelli highlighted the success of the RISCC knowledge co-production or the translational ecology approach. These approaches involve engagement from scientists in conjunction with land managers working together to identify the specific problem, information needed, and decisions it will inform. As a project progresses, managers and scientists meet on a regular basis as a team to co-produce knowledge to guide how research can inform the monitoring and how monitoring can inform research. This results in adaptive research analogous to adaptive management.

Colin Beier recalled his success working with regulators to determining critical loads for New York State. Beyond just stream chemistry, these collaborators had an ability to embrace holistic approaches that included biological, social and economic impacts of pollution. Incorporating these factors are important and more and more decision makers are receptive to this approach.

The panelists also discussed challenges to their work. One particular concern is how to increase efficiencies in light of a currently challenging and likely worsening funding environment in order to preserve core activities. Karl Honkonen cited group collaborations as the best way to find efficiencies. No one group has the time, expertise or funding but all of us working together at a landscape scale can bring these resources together. Municipalities are an often neglected partner but if they are aware, for example, that one dollar spent on good forestry practices equals 27 dollars of water treatment costs, municipalities will be on board with strategies that preserve forests.

An audience member emphasized that prevention and early detection of invasives is critical because eradication after the fact is daunting if not impossible. Toni Lyn Morelli agreed, noting that work on climate refugia is also important in order to employ triage or resistance strategies to focus on certain areas that are buffered from climate change impacts. Some sites will be more important or easier to protect - this may be the best use of limited resources.

Colin Beier noted the need for new ways of thinking about the many complex challenges that are currently facing our forests. For example, rather than simply creating forest buffers around riparian areas, we may need to create buffers that are climate adapted. This could require a rethinking our opinion of invasives, which may provide some benefit. We will need to be more flexible to create adaptive solutions for a rapidly changing future.

Summary of Working Sessions

Session summaries were made available for several sessions, and are included below. No summaries are available for “A new GIS tool for assessing forest risk from nitrogen deposition and climate change: hands-on workshop”, “Vermont Water Monitoring Council Meeting”, or “VMC Management Portal Overview and Training” sessions.

Forest Disturbance in the Northeast US: Synthesizing Field Data and Forest Health Aerial Surveys

Organizer: Garrett Meigs, University of Vermont

The primary goal of this working session was to identify methods, datasets, and outputs for linking field-based observations of forest change with aerial detection surveys in the northern forest region. The organizers presented the current status of an initiative to combine forest health aerial surveys from NY, VT, NH, ME, and MA with research data funded by the Northeastern States Research Cooperative. After summarizing work to date on aerial survey data compilation and plans for developing an online portal called the *Forest Health Atlas*, the organizers then gave examples of previous efforts to combine remotely sensed and field data. Specific examples include: (1) tree species mapping with Landsat imagery and Forest Inventory and Analysis plots; (2) combining multiple geospatial and plot-based data in an integrative forest health index; (3) combining aerial surveys of insect outbreaks with Landsat imagery and inventory plots to map tree mortality; (4) Combining aerial surveys and tree rings to elucidate patterns and drivers of change at multiple scales. The 30 participants then divided into four small groups to discuss three core themes: (1) current forest health issues of interest; (2) key datasets and methods; (3) future forest health concerns and data accessibility. The main product from this session was a summary table listing important points from each of the small groups, which will be used in forthcoming analyses and synthesis reports.

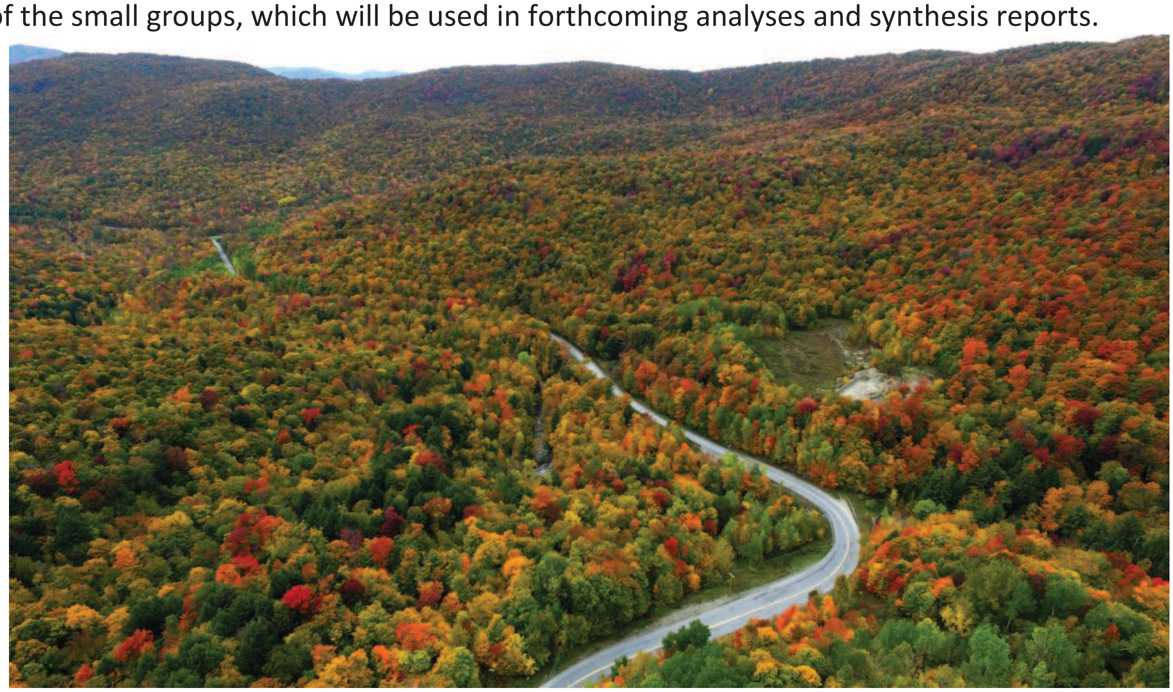


Figure 5. Aerial picture of forest surrounding Bolton Valley access road. Photo credit 802Aerial online at http://802aerial.com/

GROUP DISCUSSION NOTES FROM FLIPCHARTS

Questions	Group 1	Group 2	Group 3	Group 4
1. What are forest health issues of interest in the region? Specific agents or types of change? Chronic vs. acute changes? Relevant drivers?	Issues: Climate change: Wind storms, ice storms, mixed precipitation, changing phenology, growing season Recent changes in forest structure and composition Species composition → vulnerability/risk Stand age structure → vulnerability/risk Pollution, deposition effects on forest decline Synergistic impacts Biodiversity Drivers: Climate change (e.g. snowpack/soil freeze, drought/flood/extremes, higher temperatures and higher stress Land use (e.g. selecting maple (monoculture) Management – direct effects Fragmentation/parcelization Invasives (plants, insects) Interactions of the above! (e.g. exceedance overlap with multiple agents evident in aerial surveys)	Beech bark disease (Nectria) and associated tree regeneration Emerald ash borer Hemlock woolly adelgid Birch defoliators and decline Spruce decline (historically) Total pest load – mapping? Climate effects Needle case (white pine) – suburban areas Disturbance, especially wind and ice events Fragmentation (natural and anthropogenic) Forest management practices	Fragmentation Spreading invasive species in understory Spruce budworm Gypsy moth Winter moth Brown tail moth Southern pine beetle Hemlock woolly adelgid Sugar maple decline Hardwood decline Red pine scale Extreme precipitation events: drought/flood Warming winters Acid deposition Increased atmospheric carbon Forest type – BAI White tailed deer From flipchart 2: Hardwood decline and maple sugaring and forest tent caterpillar damage to industry Interactive effects of deer and weeds on tree regeneration	Pests Climate change Water health Development, fragmentation Habitat Biodiversity Regeneration Soil health → forest health Extreme events

2. What are additional datasets related to these regional issues? What are other methods for linking field and geospatial data? Key publications? Which approaches should be prioritized?	Geospatial data: Risk maps Natural community maps – TNC Tree species maps - % BA Forest age, biomass maps Forest health index from David, Jen Associated management history data? (federal, state, private) Parcelization Phenology (Andrew Richardson at Harvard, Landsat and MODIS based) Field data: NSRC studies! Alphabet soup: FIA, CFI, CFP, VMC USFS – state and private, ask Paul Schaberg (he was in this group) Soil pits – long term Long term sites: Hubbard Brook, Harvard Forest, Bartlett, Penobscot, Adirondack Ecological Center Methods: Use LIDAR to do fusion with FIA plot data and Landsat imagery	Data: Aerial photos 1938-1942 – need to be analyzed Inaccessible historical data – NPS 1934 Critical loads – public 1800s species composition of state Methods: Pontius and Hallett 2014 – comprehensive methods regarding forest decline Integrative approaches: field, aerial, drone Abiotic data that are relevant Bayesian methods	Data: Maine forest service – undigitized data CAPS survey (EDRR) – insects Pheromone surveys by state agencies (gypsy moth, spruce budworm) Emerald ash borer monitoring PRISM for specific climate metrics NPS INM (inventory monitoring – forest inventory plots and publications) Hubbard Brook Lidar Forest insect and disease surveys by states (70 years) Current use program – private land data (30 years – Vermont only?) Harvest records/disturbance by state – state wildlife management areas From flipchart one: Long-term monitoring plots Methods: Pick winter moth oak damage and show utility – FIA Southern New England stress on oaks → forest response * amount of injury = amount of impact? Combine climate metrics with forest type to get forest health metrics? From flipcharts 1 and 3: Pick forest type, overlay dynamics/factors and look at response to predict (risk, impacts) Model direct/indirect impact of climate on population characteristics (parameters)	Data: Hubbard Brook White Mountains National Forest – management data Spatial datasets (e.g. NDVI) Conserved land maps: What is the difference between conserved lands and other types of land?

3. Looking ahead, what are your biggest concerns for the future? What should agencies and researchers be doing differently for monitoring forest health? How can monitoring data become more accessible and/or useable?	Concerns (in addition to those in question 1): Tipping points Disturbance mediated climate change (interactions between climate and disturbance) Interacting/overlapping/cumulative impacts Regeneration that is adapted to change – Resilience = options (e.g. species migration – can/will red cedar replace yellow cedar?) Human population growth Prioritization when addressing many different issues → we need monitoring that is consistent and issue-independent Need solid baselines across landscapes (seamless) Need appropriate baselines (e.g. red spruce resurgence despite predictions of die-off) Money for long term monitoring! How deal with more complexity with less capacity? What do differently/share better? Make field data less expensive (through targeted sampling or efficient subsampling) or substitute remote sensing (FIA is doing this?) Leverage new tolls like LIDAR But retains some consistency for long term monitoring. GIS basemaps (served up rather than needing to download updates – VCGI model) Central repository/service for data among states/jurisdictions to address regional issue	Define forest health in terms of ecosystem, humans (urban forestry?) Ecosystem health, capturing all aspects of health (including social values and economic values) Data accessibility – digitizing Precise spatial data with monitoring data Agencies and researchers should consider how they interact with each other and practitioners How will climate change migration (of humans – e.g. climate change refugees) affect the spatial/aerial data collection and vice versa?	Accessibility: All previous [data] in one system is useful for academic research but overwhelming for practitioners (different levels and scope need to be disseminated at different levels) Should change social behavior (inform management, changed availability, contest specificity) Evaluation of best ways of detection based on desired outcome Relevance to general population Better understand site level factors Changing climate conditions – future impacts/predictability	Changing political climate/priorities Funding Fragmentation Did management achieve goal (forest health?) and consequences from management (pre-salvage?) Change in timber market concerns Need data standards Clearinghouse for data/sharing data

How to Best Monitor for Efficacy of Invasive Plant Control Efforts

Organizer: Robert Hyams, Lewis Creek Association, Habitat Restoration Solutions, LLC

There are a number of initiatives to control exotic/invasive plant populations that impact a range of natural communities within Vermont. Funding, whether federal, state, or NGO, typically covers cost of treatment for a calendar year. It is believed that little work is being conducted to determine efficacy outside of the first season. As a result, we are at risk of spending limited dollars and increasing chemical burden without empirical evidence to justify the means.

Monitoring Template

Monitoring plans should be a solid component of any restoration plan that outlines how progress will be documented and evaluated.

1. **Goal/s of management.** Use goals to broadly outline the desired outcomes of your treatment and set the direction of the restoration (for example, "*we want to improve the water quality in the Huron River*"). Consider whether your focus is specific to the invasive species or on restoring broader ecosystem structure and function.
2. **Implementation monitoring.**
    a. Review the treatment strategy and consider whether you want to break up treatment across several years or management zones based on species, distributions, and/or degree of infestation. How will you track your treatments? What information will you record (i.e. weather conditions, dates of application, costs, concentration, brand, and total quantity of herbicide applied, acres or stems treated)?
3. **Effectiveness monitoring.**
    a. **What will you monitor?** Consider the variables or metrics to be monitored based on the characteristics, and spatial and temporal scale, of your species of concern and your overarching management goals. (Stem density? Percent cover? Relative dominance? Frequency/Number of infected patches? Population size? Number of introductions?). Will cost-effectiveness play a role? Are you looking at ecosystem, community, or population structures and functions? Review attached page on metrics for inspiration.
    b. **Baseline condition and assessment of the problem**. Describe the extent of the infestation in terms of the variables/metrics you have chosen. Consider structural patterns of infestation as well (number of patches, patch shape, source versus satellite).
    c. **Description of target condition.** Identify the spatial or temporal reference site you used/will use to determine your target objectives. Temporal reference can be using historic conditions and can range from pre-settlement to just before the most recent disturbance.

d. **Distill your management objective/s.** Different from the broader goal, objectives should be testable, measurable targets, and, ideally, have a timeline attached to them. Use your reference site as a source for these targets.

  i. Example: *Within five years, we will reduce average annual concentrations of TP in the Huron River by 27% to match historic baseline conditions.*

e. **Describe your monitoring methodology.** You need to consider how, where, and when you will perform your monitoring in relation to your treatment plan.

  i. **Plot sizes and shapes.** What is your sampling strategy? Are you using quadrats, points, transects or other techniques? Are you keeping permanent sampling locations or rotating? Are your sampling locations random or stratified? How many sampling points will you have?

  ii. **Method.** How will you collect data?

  iii. How will you establish a **control**?

  iv. **Timing and frequency of data collection.** What is your sampling timeline based on the seasonality of your species of interest? How will you match your sampling to the scale of the species and incorporate knowledge of life history traits? How frequently will you sample? How much baseline data do you need before proceeding with treatment?

f. **Data analyses.** What should your data look like if graphed? How will you analyze it and compare it to your reference condition? Are you looking at sampling averages? Maximums and minimums? Trends? Are you aiming to get within a certain confidence interval of reference conditions? What statistics applies to your type of variables and monitoring question? How will you recognize whether you are moving from your baseline to your target condition?

g. **Adaptive management strategies.** Do you have any triggers or checkpoints in place?

  i. <u>Triggers</u> are set to identify undesirable trends in your monitoring data. For example: *If average values for percent cover increase for two years in a row, prior to reaching our target of <or = 5%, this triggers an additional cut and paint treatment in whichever treatment zone is deemed in most need.*

  ii. <u>Checkpoints</u> are designed to address additional uncertainty associated with any assumptions you made in your treatment design. For example: *We are not fully confident that two cut-and-paint treatments will be sufficient to effectively drop invasive percent cover of honeysuckle and buckthorn. Therefore, we propose that after an area has been cut-paint and burned twice, that the area be checked for the presence of resprouting invasive shrubs. It should be determined whether there are five or more honeysuckle or buckthorn shrubs of any size that exhibit resprouting within the 100sq meter monitoring transect. If this threshold is met, then no additional zones should be treated. Instead, managers should initiate a third cycle of cut-paint-burn on areas already being treated, effectively pushing treatment in other zones back one year.*

4. **Who will do this and with what tools?** Based on your methodology and data analyses, what materials and resources will you rely on? Do you have access to volunteers? How could you integrate public involvement if possible? How will you integrate photo documentation and mapping to share your success story?

5. **Budget estimate.** Integrate all of the above information to develop a budget specific to monitoring (separate from your treatment costs).
6. **Final evaluation.** This is the process of relaying monitoring results back to the decision making process. This allows space to publish success stories and lessons learned, and to use the monitoring data to accurately identify challenges and suggested changes. Determine when you will perform this evaluation and the types of questions you will need to ask. For example:
    a. *Did you reach your objectives?*
    b. *Are your objectives still desirable?*
    c. *Should the treatment be modified and/or repeated?*
    d. *What other types of treatments should be considered?*
    e. *What was the effect of the treatment to native plant and animal communities?*
    f. *Were there unforeseen side-effects?*
    g. *Were your final costs outweighed by the potential losses due to invasive species presence and spread?*
    h. *Was funding and staffing appropriate for your timeline?*
    i. *What external factors impacted implementation and effectiveness of treatment? How can you manage for these in the future?*

Template informed by:

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- *Monitoring and Evaluation*. Center for Invasive Weed Management. N.d. http://www.weedcenter.org/management/guidelines/SectionVII.pdf accessed November 30, 2016.

Fine-Tuning a Wetlands Rapid Assessment Protocol

Organizer: Charlie Hohn, Vermont Agency of Natural Resources - Wetlands Program


The Vermont Rapid Assessment Method (VRAM) is a wetland assessment protocol which is used to collect data on wetland function, value, and condition, but requires less time than a detailed survey of the plants, soil, and water quality of a wetland. The protocol is based on a similar one used in Ohio, and has been used by the Wetlands program for approximately 10 years. The protocol is now being updated to fine-tune the scoring metric and to be made usable by a broad audience. Along with a web portal and trainings, it will be available for use by interested groups including conservation commissions, land trusts, and landowners interested in conserving wetlands on their land.

This working group focused on obtaining feedback from a wide variety of people who are potential users of the protocol. Attendees included State of Vermont employees, UVM graduate students, field ecologists, and employees of local conservation groups.

The field form was reviewed line by line, with many helpful comments submitted on ways to improve of refine the form and underlying protocol. These include adjusting the 'score' assigned to different factors, addressing inconsistencies or confusing wording, and making sure that any factors that could be confusing or arbitrary are very well described in the protocol to reduce risk of inconsistent scoring. One of the most vital part of this is ensuring that all users define the area of wetland that was assessed, as looking at a subset of a wetland can result in a different score than looking at the wetland as a whole. For this reason, the protocol does not work as well with large wetland complexes that cannot be assessed in one visit; those types of wetlands require more detailed assessments.

Another important topic of conversation was the resulting 'score' and what it tells the user about the wetland. The 'grand total' score includes several factors important to understanding wetlands including their condition and level of disturbance but also the functions and values they provide such as flood control and wildlife habitat. This score does a good job of identifying wetlands that provide high value and function and are in good condition. However, some important wetland types such as bogs may receive a relatively low score even if in excellent condition, because they are small and do not contain as high a diversity of habitats and hydrologic regimes. For this reason, the plan is to generate a different index along with the grand total, that derives from only the factors related to wetland condition, such as human disturbance to hydrology and presence of invasive species. This index, rather than the 'grand total' score, should be used when the desire is to assess only the *condition* of the wetland. Testing within the Wetlands program has shown that this is an effective way to assess wetland condition independent of function. Likewise, an index will be created to give an overview of the *functions* provided by the wetland independent of condition.

Contributed Abstracts

There were 25 talks contributed to the conference, presented between two sessions throughout the day. In the morning there were three concurrent sessions. There were two sessions of Watershed Management moderated by Alexandra Kosiba and John Truong and the first portion of Monitoring and Assessment moderated by Emma Tait. In the afternoon session of talks there were four concurrent sessions. The concurrent sessions were Landscapes moderated by Rebecca Stern, Wildlife moderated by Emma Tait, Monitoring and Assessment continued moderated by Julia Runcie, and Drivers of Change moderated by Alexandra Kosiba. Below are the abstracts submitted for these talks, including author affiliation. The presenting authors name is in bold type.

15,001 Trees and Counting

Elise Schadler[1]

[1] Vermont Urban & Community Forestry Program

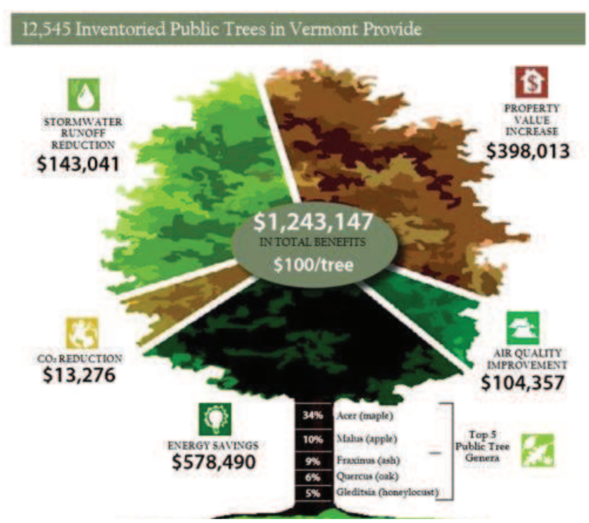


Figure 6. The monetary values of the environmental services public trees in Vermont provide.

In 2013 the VT Urban & Community Forestry Program (VT UCF), a collaborative effort of the VT Dept. of Forests, Parks, & Recreation and UVM Extension, received a multi-year grant from the USDA Forest Service to support 20 priority Vermont communities in moving their urban and community forestry programs forward. The project focused on a three-pronged approach: 1) Providing assistance in inventorying the public trees in the community, 2) Working with municipal staff and/or volunteers to develop (or update) a management plan for the community's public trees, and 3) Coordinating a training for municipal staff (Public Works, Roads Dept., Parks & Recreation) and citizen volunteers to be trained in basic tree care best practices. VT UCF collaborated with the GIS Team at the Agency of Natural Resources to develop a robust, cloud-based, user-friendly inventory tool for this effort. And in addition to the 20 towns included in the project, an additional seven communities' public trees have been inventoried based on local interest. To date, data have been collected on 15,0001 trees along residential streets, in downtowns, in parks, and at schools. We are eager to share our analysis of the trees that make up Vermont's urban forests, as well as our VT-specific tree inventory tool and lessons learned from engaging with the municipal leaders, staff, and citizens that manage and care for public trees.

The Monkton Amphibian Underpass

Jim Andrews[1]

[1] Vermont Reptile and Amphibian Atlas

Vermont's first amphibian tunnels were built in 2015 and successfully allowed over 2,000 crossings this spring. I will discuss what makes a crossing area significant, how the crossings were designed, and show a short video of amphibians and other wildlife using the underpasses. The video can be viewed at https://youtu.be/wWAERJjH9fM?t=960

Figure 7. Construction of the Monkton amphibian underpass

Modeling Hemlock Woolly Adelgid Risk and Impacts of Presalvage Harvesting on Carbon Stocks in Northern Hemlock Forests

Jennifer Pontius[1,2], Jeffrey Krebs[1], William Livingston[3], Kara Lorion[3], Stacy Trosper[3], Paul Schaberg[3]

[1]University of Vermont
[2]U.S. Forest Service Northern Research Station
[3]University of Maine

Two recent studies provide useful information on the management of northern hemlock stands in light of encroaching hemlock woolly adelgid (HWA) infestations:

- Dendrochronological assessments of HWA impacts on hemlock allowed us to examine variable rates of growth decline following incipient infestation. Results indicate that the magnitude of growth decline was significantly greater on sites with specific site characteristics. Applying a spatial logit model based on these characteristics differentiated high- and low-BAI-reduction stands with 80% accuracy across 41 calibration sites and 73% accuracy across 15 independent validation sites. Applied across the northeast, the resulting spatially explicit risk model shows the likelihood of hemlock growth declines when HWA arrives.

- Stand development simulations under various management scenarios allowed us to model the potential impact of HWA infestation and management activities on C dynamics in northern hemlock stands. Using FVS and FIA data to model C storage and successional pathways under presalvage harvesting, HWA infestation and no disturbance scenarios we found that both presalvage and HWA scenarios had significantly lower total C than the control at the end of the 150-year simulation. However, the cumulative net C gain was lower for the presalvage than HWA scenario, indicating that allowing HWA to progress naturally through a stand may result in the least impact to net C storage.

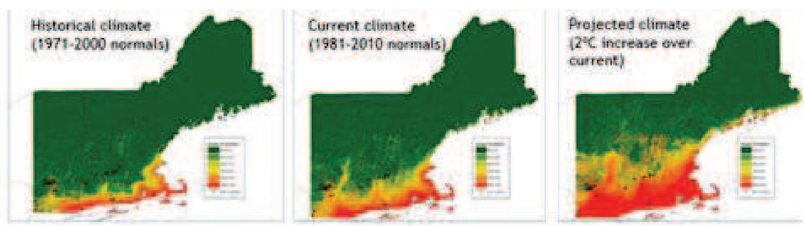


Figure 8.Hemlock growth response results across three climates scenarios

These studies, along with knowledge of current HWA infestation borders, can be used to direct management efforts, with the intention of minimizing HWA-induced hemlock mortality and maintaining the regions carbon stocks.

Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape

Eric Sorenson[1]

[1]Vermont Fish and Wildlife Department

Climate change and the expected effects on species distribution and natural community composition have led to refinements in how we plan for biodiversity conservation. Coarse-filter conservation focused on representing high quality examples of natural communities and ecosystems is still very important, but we also need to address coarse filter conservation at the landscape scale.

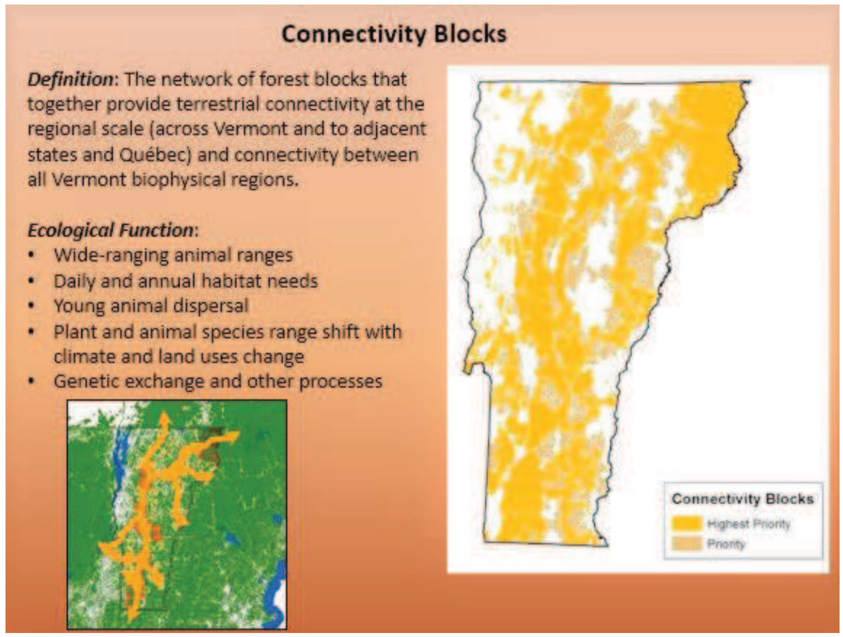


Figure 9. Definition and example of connectivity blocks within Vermont

The Vermont Conservation Design is a practical approach to protecting and enhancing an ecologically functional landscape - a landscape in which plants and animals are able to thrive, reproduce, migrate, and move as climate changes and in which ecosystems can continue to function under natural processes. The project is a collaboration between the Vermont Agency of Natural Resources, and conservation partners, and is part of Vermont's Wildlife Action Plan.

We identified five landscape features that will be most effective as coarse filters for conserving finer-scale elements. The documentation of which species, natural communities, and habitats will be captured by these coarse filters was a key step. The five landscape features are Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, Riparian Areas for Connectivity, and Physical Landscape Diversity Blocks. Selection criteria for each of these elements results in a landscape-scale conservation design and map. The project used readily available GIS data in which we have high confidence in the quality. Future steps will be to identify which natural community types, rare species, and habitats (including young and old forests) are effectively captured by this coarse-filter design and to set conservation targets for those that need specific conservation attention.

Photopoint Monitoring in the Adirondack Alpine Zone

Julia Goren[1]

[1] Adirondack Mountain Club Summit Steward Program

Fragile alpine species in heavily used recreation areas are threatened by human trampling. For sixteen years the Adirondack High Peaks Summit Steward program has utilized photopoint monitoring to document changes in alpine vegetation with a particular focus on areas subject to human trampling. Photopoints are photographs of a landscape area taken repeatedly from the same exact position, showing qualitative changes over a set time. Photopoint series were compared over time between mountains with regular steward presence versus mountains without a regular steward presence. These series showed a significant difference in vegetation change over time. Further monitoring and analysis of this data set is in progress, but results suggest that the Adirondack High Peaks Summit Steward program is making a difference in vegetation recovery in New York's alpine region.

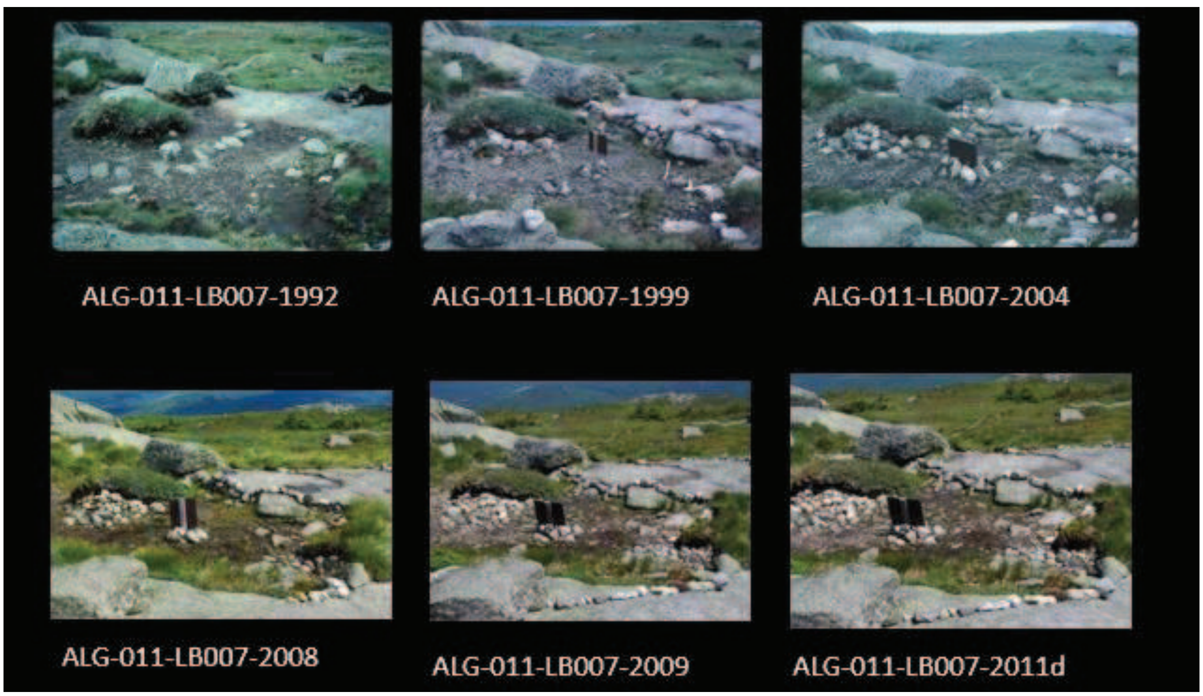


Figure 10. An example of the photopoint records the stewards have by monitoring the Algonquin peak from 1992 to 2011.

Identifying Species at Risk from Nitrogen Deposition in Forests in the Northeastern U.S.: A Geospatial Analysis Using Exceedance of Critical Loads

Linda H. Pardo[1]

[1] USDA Forest Service, Northern Research Station

Maintaining commercially important tree species, as well as species valued for ecological, social, and cultural reasons, is becoming increasingly challenging in the northeastern U.S. due to the significant threats impacting ecosystem health and sustainability over the long term, in particular climate change and nitrogen (N) deposition. We developed a GIS-based tool, Nitrogen Critical Loads Assessment by Site (N-CLAS), to evaluate the impact of multiple stressors (N deposition and climate change) simultaneously for species of management concern on public and private forest lands. In addition to calculating species-specific critical loads, N-CLAS is designed to take into account the impact of site abiotic factors on the response of trees to N deposition. The abiotic modifying factors include, precipitation, temperature (e.g., January T, July T, May-September T), and soil characteristics. Application of N-CLAS across the northeastern U.S. allows us to evaluate which areas and tree species are most susceptible to impacts from N deposition. N-CLAS can determine the critical load and exceedance for individual tree species or all the species present. N-CLAS also provides information about the % of the area where deposition is in exceedance of the critical load and the % area by species at risk at any given deposition level. We are incorporating climate change scenarios in order to explore the interaction between climate change and nitrogen deposition. Thus, we will be able to determine the fraction of the region that is susceptible to detrimental impacts of N deposition under projected climate scenarios. Use of this tool provides resource managers with a simple way to incorporate the current state-of-the-science knowledge into their planning and management decisions.

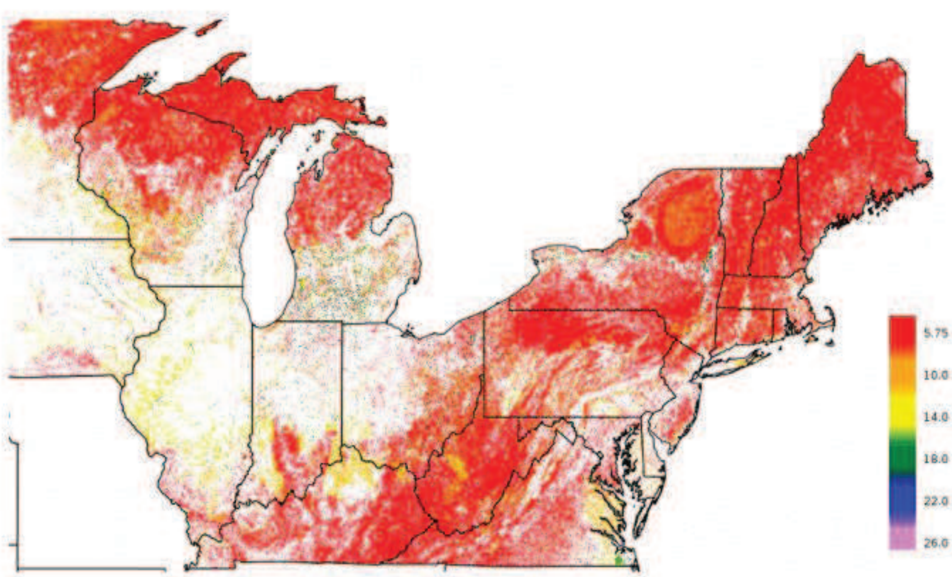


Figure 11.Most protective critical loads for most sensitive species (kg N/ha/yr). Red is the lightest load at 5.75 while light purple is the heaviest loads at 26.0.

Regional Environmental Monitoring Through Collaborative Research at the Cary Institute of Ecosystem Studies in Millbrook New York

Vicky Kelly[1]

[1]Cary Institute of Ecosystem Studies, Millbrook NY

Environmental monitoring at the Cary Institute is designed to provide long-term data about environmental conditions, especially those that have been altered by human activities. The program includes monitoring of weather and climate, air, precipitation and stream water chemistry, as well as solar radiation and the movement of water in the landscape. Other long-term research programs at Cary monitor organisms and conditions such as deer and their impact on forest structure, birds, ticks and Lyme disease and forest health. Collaborative research and network participation allows us to contribute to regional monitoring and to help inform regional policy and management. We currently host sites for National Atmospheric Deposition Program for air ammonia, US Climate Reference Network for climate and the NY Department of Environmental Conservation for atmospheric ozone and SO2 monitoring. Other collaborations include work with NOAA Cooperative Remote Sensing and Technology Center and USDA Agricultural Research Service to monitor soil moisture and temperature at multiple sites as part of the NASA Soil Moisture Active Passive mission. The Cary Institute is a member of the Environmental Monitoring and Management Alliance (EMMA), a regional alliance of sites along an urban to rural gradient from New York City to near Albany. The EMMA network aims to monitor environmental conditions across a regional gradient in order to provide information to develop, justify or adjust management strategies in the face of pressing environmental issues such as climate change and deer overabundance. EMMA monitors phenology via citizen science volunteers using the framework of the USA National Phenology Network. EMMA weather and deer impact data are managed via the Vermont Monitoring Cooperative (VMC). This talk will provide an overview of the Cary Institute's environmental monitoring with emphasis on the EMMA collaborative and its data management with the VMC.

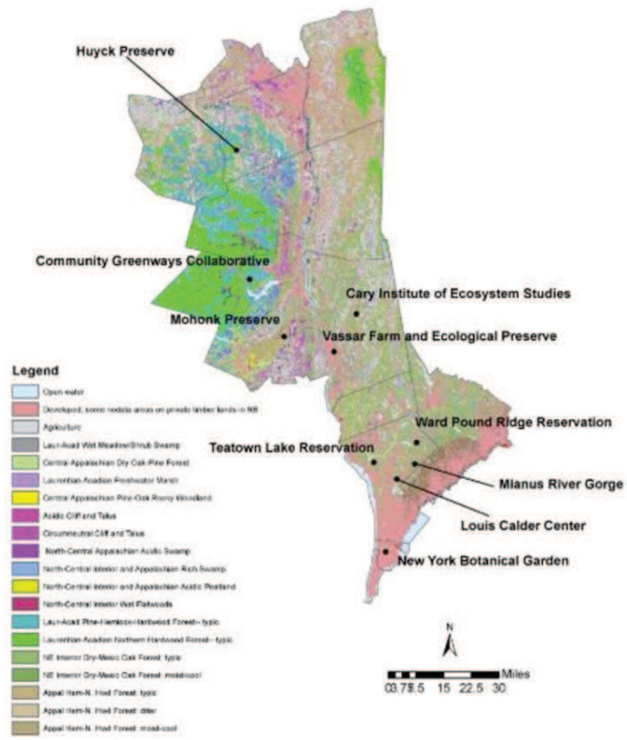


Figure 12. Habitat types within the EMMA region.

Bioaccumulation and Trophic Transfer of Methylmercury in Wood Frogs and Spotted Salamanders in Vermont Vernal Pools

Steve Faccio[1], Kate L. Buckman[2], Vivien Taylor[3], Amanda Curtis[2]

[1]Vermont Center for Ecostudies
[2]Department of Biological Sciences, Dartmouth College, Hanover, NH
[3]Department of Earth Sciences, Dartmouth College, Hanover, NH

Mercury contamination via atmospheric deposition and leaf fall is widespread in the Northeast, and hotspots with enhanced deposition and biological uptake have been identified throughout the region. Due to their relatively high organic matter and low oxygen levels, vernal pools provide ideal conditions for the conversion of mercury to its more toxic and bioavailable form, methylmercury. Yet little is known about the presence, cycling, and methylation rates of mercury in vernal pools, its effects on vernal pool fauna, and potential export into terrestrial systems. We have been investigating the role of land-use and landscape characteristics on the production and transfer of methylmercury in vernal pool food webs. We analyzed mercury levels in samples of water, soil, leaf litter, an array of invertebrates from several trophic levels, and eggs, larvae and adult amphibians. This presentation will summarize preliminary results of methylmercury concentrations in wood frog and spotted salamander eggs, larvae, and adults from six vernal pools in east-central Vermont.

Figure 13. Wood frog eggs (top) and salamander eggs (bottom).

30 Years of Forest Conversion in the Northeast: Historical Patterns and Future Projections

Alison Adams[1], Jennifer Pontius, Gillian Galford, Scott Merrill, David Gudex-Cross

[1]University of Vermont

Land use and land cover across the northeastern United States has changed dramatically over the past century. While these changes are highly visible to land managers and planning professionals on a local level, regional information on the nature and extent of these changes has been limited. Thanks to the wealth of historical satellite imagery that has recently become freely available, we are now able to look, with sufficient temporal resolution (5 year intervals from 1985 to 2015), at the patterns and rates of land cover change across the Northeast. In this study we utilized recently-developed maps of land cover in the Northeast to quantify changes in the landscape over the past thirty years, looking particularly at transitions to and from forest. This information is critical to inform adaptive forest management in the face of increasing development and parcelization, as well as converging stress agents across the region. Using Dinamica EGO, a sophisticated spatial modeling platform, we identified significant drivers of historical change and simulated future changes in land cover. Here we present historical and projected changes in forest pattern and extent for the northeastern US from 1985 to 2060.

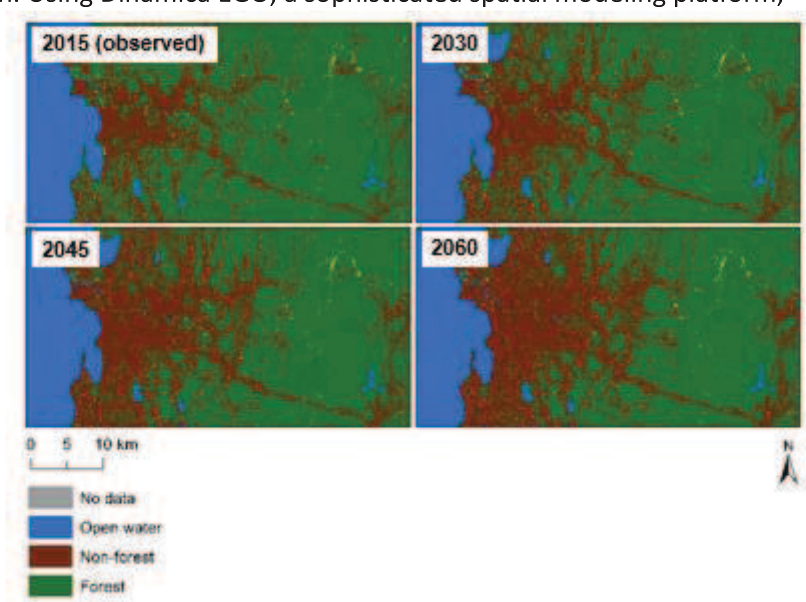


Figure 14. Simulated maps showing increasing non-forest overall in the Burlington, VT area.

The Role of Forests in Maintaining Water Quality in the Lake Champlain Basin

Kristen Underwood[1], Donna M. Rizzo, Corrie Miller, Matthew Witten

[1]University of Vermont

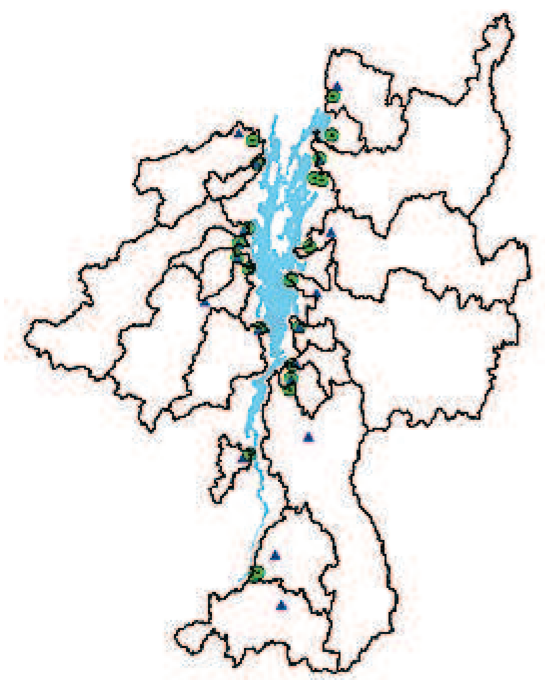


Figure 15. Lake Champlain long-term tributaries. Monitoring has occurred from 1990 to present with 14 to 19 samples collected per year at 22 different tributaries.

Forests have been recognized for their role in moderating stormwater runoff and preserving water quality. Long term monitoring data for Lake Champlain tributaries suggest a positive correlation between percent forest cover and higher-quality river water. Finer-scale analysis of land cover and soil factors correlated to water quality would be helpful to towns and regional stakeholders engaged in planning efforts to reduce stormwater runoff and sediment/nutrient loading to Lake Champlain. We analyzed water quality data from years 2010 through 2015 for 36 stations in six Lake Champlain Basin watersheds monitored by the Addison County River Watch Collaborative and Friends of the Mad River under the LaRosa Volunteer Water Quality Monitoring Partnership. Analysis of soil and land use characteristics in direct-drainage areas (DDAs) to each of these stations, at both the Sub-watershed and Corridor scale, revealed strong, and statistically-significant, positive correlations between mean water quality concentrations (for Total Phosphorus [TP], Turbidity and *E. coli*) and percent glacial lake soils, percent very-low- and low-infiltration soils, and percent agricultural land use. Conversely, percent forest cover was strongly correlated, in a negative sense, to concentrations of these same constituents. Results underscore the importance of intact, healthy forest blocks and forested riparian areas for maintaining water quality in these watersheds.

Rusty Blackbirds in the Northern Forest: Breeding Season Status and Habitat Associations at Local and Landscape Scales

Stacy McNulty[1], Shannon H. Buckley Luepold, Amanda L. Pachomski, Carol R. Foss, Thomas P. Hodgman, Jonathan Cohen, and Shannon Farrell

[1]SUNY College of Environmental Science and Forestry

Rusty Blackbird (*Euphagus carolinus*) populations have plummeted since the mid-20th century. This boreal wetland-breeding bird has experienced one of the most significant declines ever documented among extant North American birds (> 90% since 1960). We explored the mechanisms by which an ecological trap may be operating in New England through a multiscale analysis of Rusty Blackbird habitat selection and nest survival, as well as predator identification and quantification. We located 72 nests in Maine and New Hampshire in two breeding seasons, and modeled habitat selection and nest survival as a function of habitat characteristics at the nest patch (5 m) and home range (500 m) scale. We placed camera traps at 29 nests to identify nest predators, and surveyed squirrel abundance each year. Rusty Blackbirds selected nest patches with high basal area of small conifers and low canopy closure. Nest survival was not reduced in harvested stands, but increased with increasing basal area. Percent cover of wetlands and young softwood stands were the best predictors of Rusty Blackbird selection at the home range scale. Red squirrels were the most frequent predator of nests following a conifer mast year. Dense cover of small softwoods is important for habitat selection and survival of Rusty Blackbird nests; some management activities such as roads or pre-commercial thinning near wetlands may negatively impact habitat quality for this species. We did not find evidence that harvested stands acted as ecological traps for Rusty Blackbirds, as the preference for patches of short, dense conifers appeared to be adaptive even when such habitat was the result of logging activities. We will also share results of a recent Rusty Blackbird foraging study in beaver-influenced wetlands in New Hampshire and survey results from the Adirondack Mountains of New York that have implications for forest and watershed management at fine and landscape scales and for conservation of this sentinel boreal species.

Figure 16. Camera traps captured images of predation events on rusty blackbird nests. White-tailed deer (top), blue jay (middle), red squirrel (bottom).

Estimating the Source of American Martens (Martes Americana) in Vermont and Their Genetic Structure in the Northeastern United States

Cody Aylward[1], James D. Murdoch[1], C. William Kilpatrick[1]

[1]University of Vermont

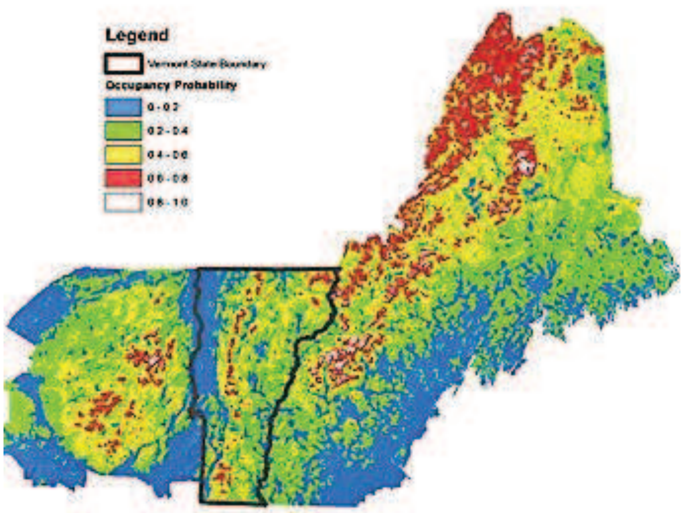


Figure 17. Model created by Cody Aylward showing the occupancy probability of American martens (Martes americana) in New York, Vermont, New Hampshire, and Maine.

American martens (*Martes americana*) have returned to Vermont after a perceived >35-year absence. One population in southern Vermont is believed to be remnant of a 1989-91 reintroduction effort that was previously deemed unsuccessful. A second population in northeastern Vermont is believed to have been colonized by dispersers from New Hampshire. We estimated the source of martens in northern and southern Vermont and genetic structure of the broader population in the northeastern US. We used D-loop sequences of mitochondrial DNA to estimate differentiation among southern Vermont, northern Vermont, New York, New Hampshire, and Maine populations and female genetic structure across the northeast. Eleven microsatellite loci were used to exclude populations as potential sources of individuals from Vermont, predict the most likely population of origin for individuals from Vermont, and detect overall genetic structure across the northeast. To date, mtDNA results indicate the southern Vermont population is a remnant of the reintroduction. Preliminary results of population exclusion/assignment tests and estimates of genetic structure will be available by November 2016. Final results will be available in Spring 2017.

Defining and Targeting High Flows

Bill Hoadley[1]

[1]South Chittenden River Watch

The SCRW Volunteer Water Quality Monitoring Program samples the LaPlatte River and McCabe's Brook which drain into Shelburne Bay and Thorp and Kimball Brooks which discharge into Town Farm Bay. Program objectives include 1) identification of "hot spots" and need for mitigation and improved watershed management practices, 2) informing efforts to protect and improve water quality in our streams and receiving waters, and 3) establishment of baseline conditions for assessing trends and the effectiveness of measures taken to improve water quality in streams and nutrient loadings on their receiving water bodies.

Since the initiation of the SCRW program in 2004, our sampling program and monitoring strategies have evolved as our understanding of factors affecting water quality in our streams and of loadings on the lake and as our priorities have come increasingly into focus. Key to this evolution have been an emphasis on the analysis and interpretation of our data, undertaking related studies outside the LaRosa program, redesign of our program in the context of the proposed 5-year basin planning cycle, and a willingness of the DEC to accommodate significant changes from the monitoring program as initially conceived.

Among the changes initiated have been1) the establishment of strategically located "sentinel" sites sampled yearly and more extensive coverage sampled for 2-year periods tied to the planning process, and 2) a shift from random flow sampling to the targeting of high flows. It is the purpose of this presentation to discuss the basis for defining and targeting of high flow rates, including 1) analysis of phosphorus burdens associated with suspended sediment, 2) particle size analysis, 3) in-stream sediment and nutrient mass balance analysis based on in-stream flow measurements, and 4) nutrient loading rates in relation to stream discharge rates.

Results of our analyses revealed a "critical" or "threshold" stream discharge rate above which 1) the bulk of the sediment and nutrients are discharged to the receiving waters and 2) discharges into receiving waters are representative of contributing watersheds. These results have provided a basis for defining high flows. We have found, furthermore, that in spite of local variations in rainfall, flow measured at the USGS gaging station on the LaPlatte river was a fairly good indicator of discharge levels in all streams we sample. Whereas stream monitoring of flow contributed greatly to our understanding sources of sediment and nutrients at sub-watershed level and their behavior in relation to discharge rates, as well as for comparing watersheds, installation and maintenance of staff gages was found to be too costly to continue monitoring flow rates at sub-watershed level. The targeting of high flow rates, however, while it requires careful monitoring of discharge rates and weather forecasts, and flexibility and depth of sampling teams, as well as willingness of the laboratory to accommodate unpredictable sampling schedules, has proved feasible.

Finally, it is hoped that by targeting high flows, and thereby increasing the comparability of results over time, we can enhance our ability to observe trends, assess changes in water quality and loadings to Lake Champlain to, then, inform optimal water quality improvement practices at strategic locations within catchment and subwatershed locations.

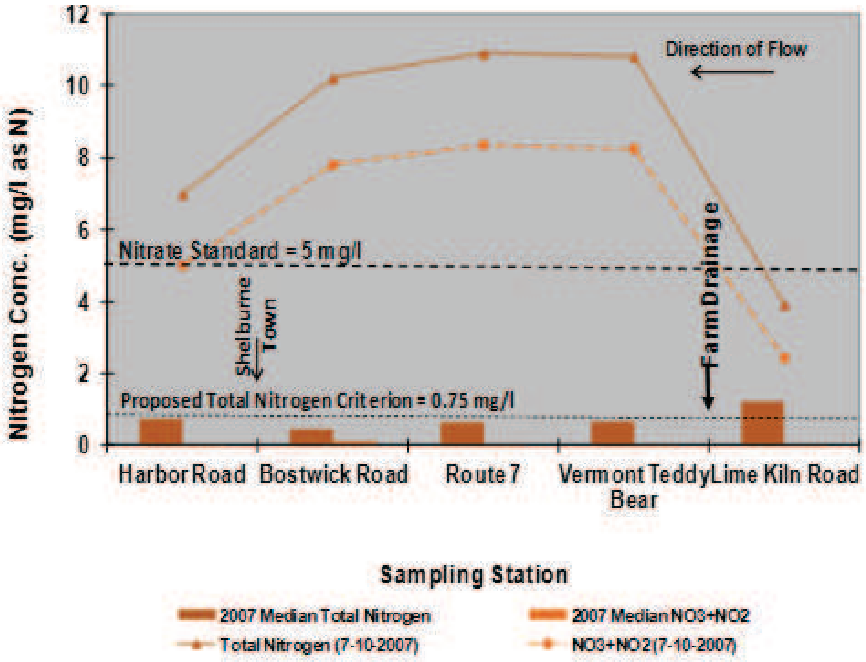


Figure 18. Nitrogen concentrations in McCabe's Brook - July 10, 2007.

Moose in Northern New England - Populations, Forest Management, and Climate Change

Peter Pekins[1]

[1]University of New Hampshire

Abstract

The New England moose (*Alces alces*) story is only 35-40 years old and continues to evolve. Population dynamics (growth, decline, stability), both moose and forest harvest strategies, economics and cultural values, and parasites/pests including the winter tick (*Dermacentor albipictus*), brainworm (*Parelaphostrongylus tenuis*), and spruce budworm (*Choristoneura fumiferana*) all influence moose populations. Although local moose density can be high and affect forest regeneration and species composition, studies in 3 states have found minimal impact when accounting for growth out to 20 years. Local populations can and have been reduced to address specific forest management concerns and moose-vehicular collision rates. However, of more concern is the winter tick, an ectoparasite of moose that has had increasing impact on calf survival and adult productivity. Population models based on current research point to a slow, long-term moose decline due to its impact. Climate change in the form of shorter winters is the driver in these models because of its positive influence on winter tick abundance. Because adult moose mortality from winter tick parasitism is uncommon, yet productivity is reduced, maintaining and/or enhancing productivity will depend on the continual availability of optimal habitat provided by commercial forestry.

Figure 19.Ticks found on a calf during a tick count.

Defining Forest Health in Managed Forests

Sandy Wilmot[1]

[1]VT Department of Forest, Parks, and Recreation

Definitions are important when attempting to detect changes that will have extensive and/or long-lasting impacts on forest functions, on landowner's products, and on nature-based services that forests provide to us free of charge. Our State definition of healthy forests builds off Aldo Leopold's concepts of self-renewal and resiliency. Is this even possible under our new climate future? This presentation will review current forest conditions, current stress agents, and explore the various situations where new definitions and metrics may be needed.

Figure 20.Aerial survey monitoring forest tent caterpillar defoliation within Vermont's forests.

The Application of LiDAR to Watershed Management on the White Mountain National Forest

Landon Gryckowski[1]

[1]White Mountain National Forest

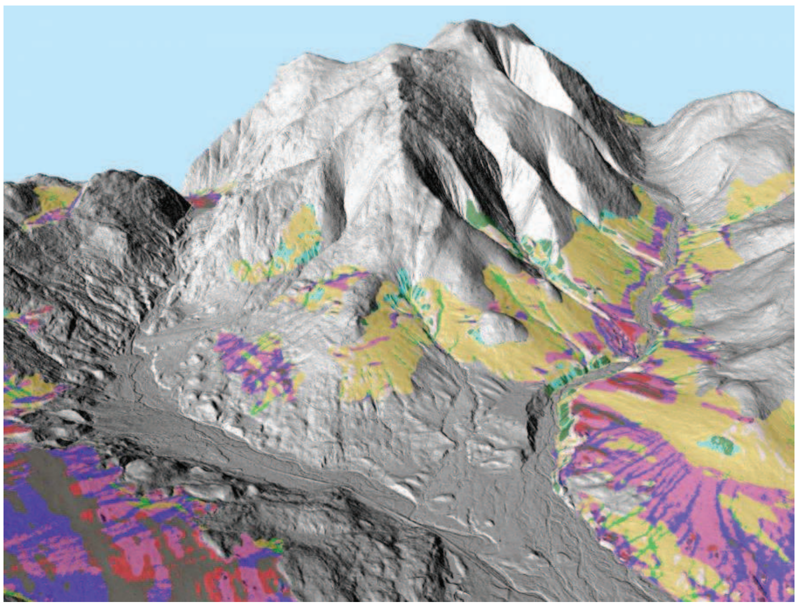


Figure 21. Example of forest-wide soil mapping and terrestrial ecological unit (TEU) mapping.

Newly-acquired LiDAR data across many parts of the country have allowed land management agencies to see and analyze the landscapes they manage in new ways. One of the products of LiDAR is a high-resolution digital elevation model (DEM) of the ground surface. Using this DEM, many aspects of watershed management are improved; for example, headwater streams can be visualized and mapped, geomorphic landforms can be identified for use in soil surveys, and watershed boundaries can be refined. Field efforts to map important features within a watershed are therefore streamlined, which increases efficiency. As LiDAR data become increasingly available across the White Mountain National Forest, land managers are beginning to apply the tools and techniques enabled by LiDAR data to better manage the Forest and its watersheds.

Bioassessment in Vermont's Forested Wetlands: Past, Present, and Future

Charlie Hohn[1,2], Tina Heath, Laura Lapierre

[1]Vermont Agency of Natural Resources
[2]Wetlands program

The Vermont Wetlands Program conducts bioassessments on Vermont wetlands, many of which are forested ecosystems. Monitoring and assessment work includes intensive field surveys (including the EPA National Wetland Condition Assessment) in which data on plant species, soil, hydrology, and water quality are collected to determine wetland condition across the state. Additionally, rapid assessment data on the wetland's landscape characteristics, functions, and conditions are collected with a protocol known as the Vermont Rapid Assessment Method(VRAM). This tool is meant to complement and approximate overall wetland quality in a shorter amount of time. The VRAM protocol is being updated and will soon be rolled out with a web portal and citizen science manual for use by the public and interested stakeholders.

General findings from our data collection confirm that wetlands with lower disturbance and with large intact forested buffers tend to be in good condition with better water quality, and score higher on several condition and function metrics than those without these features - underscoring the importance of both intact forested wetlands and the upland forests in their buffers and watersheds. Our plant diversity data also illustrate the importance of forested wetlands as among the most biodiverse of Vermont's forested ecosystems.

Figure 22. Seepage swamp in Ripton, VT.

Regeneration Responses to Management for Old-Growth Characteristics in Northern Hardwood-Conifer Forests

William Keeton[1, 2], Aviva Gottesman[1, 2]

[1]Rubenstein School of Environment and Natural Resources,
[2]University of Vermont

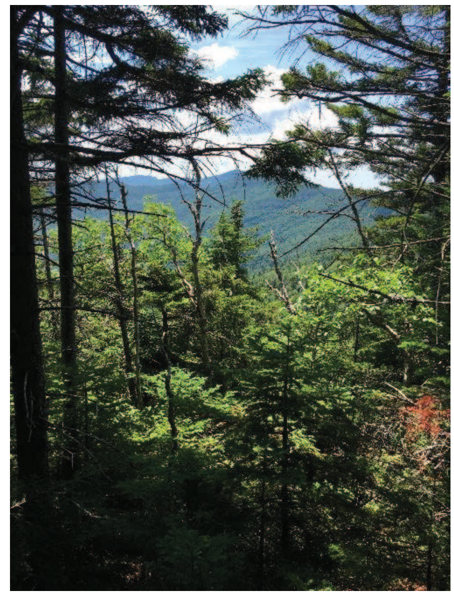


Figure 23.Vermont hardwood-coniferous forest

Forest management practices interact with multiple sources of variability to influence regeneration trends in northern hardwood forests. There is uncertainty whether low-intensity selection harvesting techniques will result in adequate and desirable tree regeneration. Our research is part of a long-term study that tests the hypothesis that a silvicultural approach called "structural complexity enhancement" (SCE) can promote accelerated development of late-successional forest structure and functions. Our objective is to understand the regeneration dynamics following three uneven-aged forestry treatments modified to increase postharvest structural retention: single-tree selection, group selection, and SCE. In terms of regeneration densities and composition, how do light availability, competition, substrate, and herbivory interact with treatment effects? To explore these relationships, manipulations and controls were replicated across 2-hectare treatment units at two sites in Vermont, USA. Forest inventory data were collected pre-harvest and 13 years post-harvest. We used linear mixed effects models with repeated measures to evaluate the effects of treatment on seedling and sapling abundances and diversity (Shannon-Weiner H'). Multivariate analyses evaluated the relative predictive strength of treatment versus alternative sources of ecological variability.

Thirteen-years post-harvest, the harvested treatments were all successful in recruiting a sapling class with a significantly higher mean than the control. However, in all of the treatments prolific beech sprouting dominated the understory in patches. Seedling densities exhibited pulses of recruitment and mortality with a significant positive treatment effect on all harvested treatments in the first four years post-harvest. Seedling diversity was maintained, while sapling diversity was negatively influenced by the presence of herbivory (deer and moose browse) and leaf litter substrate. Multivariate analyses suggest that while treatment had a dominant effect, other controls were strongly influential in driving regeneration responses. Results indicate variants of uneven-aged systems that retain or enhance stand structural complexity, including old-growth characteristics, generally show resilience to regeneration limitations depending on site conditions.

Strategies for Reducing Phosphorus Loading and Sedimentation from Forestry Operations in Vermont

Gary Sabourin[1]

[1]VT Dept. of Forests, Parks, and Recreation

Sediment is the most common pollutant associated with timber harvesting. Soil is carried by rainwater after timber harvesting equipment and trees dragged or carried over the ground loosen and expose the soil. Bare ground exposed during harvesting operations can be eroded by rainwater and enter nearby streams. Stream crossings used during harvesting are a particular area of concern. An estimated 16% of the total phosphorus load delivered to Lake Champlain comes from Vermont forestland. With forest covering more than 4.4 million acres state-wide and representing 75% of Vermont's total land base, forestry is an important area of focus for reducing sediment and phosphorus loading to state waters.

Figure 24. Projects aimed towards improving water quality in the Lake Champlain Basin. Projects include controlling soil erosion on logging trails, improving stream crossings, restoring forest riparian buffers along streams, and stabilizing erosion-prone soils

The Environmental Monitoring and Management Alliance (EMMA) And White-Tailed Deer Monitoring for Management

Lynn Christenson[1]

[1]Vassar College

Figure 25. Impact on forest understory from high deer density.

In the NE USA, white-tailed deer have become a target species for both forest managers and animal rights activists. This leaves managing deer a complicated prospect. EMMA is a group of Hudson Valley Preserves utilizing multiple methods to control deer, while collecting ecosystem scale data that is relevant to other land managers challenged by deer overabundance. By partnering with the VMC, EMMA can provide both data and insights into the area of deer management in urbanized landscapes. A continuing long-term project for EMMA, established in 2013, monitors ecosystem response to varying deer densities. Using multiple, paired-plot, exclosed and unexclosed areas, located along an urban to rural gradient, this project measures and evaluates a suite of ecosystem variables under no deer activity, low deer activity, moderate and high deer activity and include; plant response (success and survival), soil and microbial response (carbon and nitrogen dynamics) and biodiversity response (plant and animal populations).

Changing Tree Species Distributions: A 30-Year Investigation into Spatiotemporal Trends

David Gudex-Cross[1], Jennifer Pontius[1]

[1]University of Vermont Rubenstein School of Environment and Natural Resources

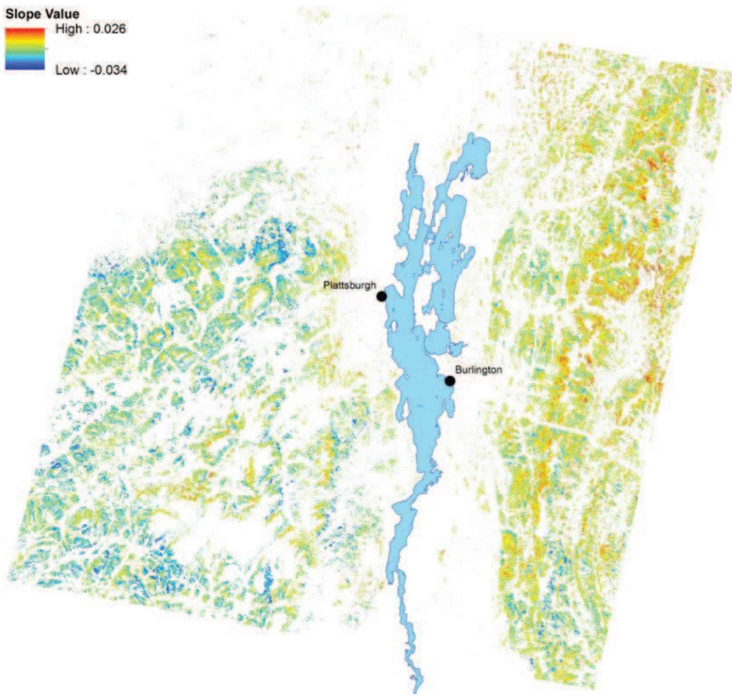


Figure 26. Sugar maple trends within Vermont and New York. There is a negative trend across elevations.

Northeastern forests are dynamic assemblages of tree species whose composition is influenced by succession, disturbance, and forest management. Recent evidence suggests that climate change is also impacting species distributions, with species such as northern red oak (*Quercus rubra*) projected to become more common across the region while others, like sugar maple (*Acer saccharum*), are likely to become less common. However, these projected changes have largely been modeled at a coarse spatial resolution based on relationships between current species ranges and environmental variables.

Here we present preliminary results on how the abundance and distribution of ten key northeastern tree species has changed over the past 30 years by leveraging a novel set of species abundance maps. In five-year time steps beginning in 1985, we quantify overall trends in species percent basal area to identify species generally increasing ("winners") and decreasing ("losers") in abundance across the region. By fitting a regression to the percent basal area data at each 30m pixel, areas of generally increasing and decreasing composition can also be identified for each species. Linked to ancillary environmental variables such as elevation, climate, soil, and site characteristics, we begin to explore spatial patterns in changing forest composition and what this implies for the future of the region's forests.

Continuous Forest Inventory Across Vermont State-Owned Land in the Northeast Kingdom

Emily P. Meacham[1]

[1]Vermont Department of Forests, Parks, and Recreation – State Lands Program

The Vermont Department of Forests, Parks & Recreation State Lands Program has established over 100 permanent plots in the Northeast Kingdom to begin Continuous Forest Inventory for Vermont State-owned Lands. Continuous Forest Inventory (CFI) is a monitoring system started in 1947 by C.B. Stott to address the need to measure forest growth in addition to current forest conditions. Data collected from CFI plots will help land managers calculate growth rates and monitor changes in the forest ecosystem. This type of inventory will also improve our ability to understand changes in the forest over time and across management regimes due to both natural disturbance events and active management. Additionally, CFI provides a consistent set of inventory data and creates a solid baseline for forest research.

Figure 27. Gavin Cook (CFI intern 2015) measuring tree height in Victory state forest.

Vermont Department of Forests, Parks & Recreation Continuous Forest Inventory will include a complete measurement of tree growth, decay, and regeneration. Each plot will be measured every 5 years. After the second season of plot establishment, there are now over 100 permanent plots across the Victory Management Unit and Willoughby State Forest at a density of one plot per approximately 200 acres. The Vermont Monitoring Cooperative has taken the CFI raw data and created a coherent database that is available for public use. This data can be used for a variety of projects and research. For example, UVM Forestry Professor Anthony D'Amato intends to use the CFI data to develop fine-resolution maps for use in his work. Additionally, the Department of Forests, Parks & Recreation hopes to use this data to calculate forest growth and accelerate the long range planning process.

Do Invasive Earthworms Affect Maple Regeneration?

Josef H. Gorres[1]

[1]Plant and Soil Science, University of Vermont, Burlington

Figure 28.An earthworm

The invasion of earthworms in northeastern hardwood forests has affected considerable changes in soil structure and understory vegetation. In combination these understory modifications with browsing by deer is thought to reduce seedling survival. We are reporting on two years of monitoring of earthworm infested 10 sugar maple stands in 2015 and 39 stands in 2016 in four frost-hardiness zones from Vermont to Connecticut. We measured forest floor damage using the Invasive Earthworm Rapid Assessment Tool, determined earthworm and plant community, as well as sapling abundance. We found 10 different earthworm species during out investigation which represents about 50% of the known species in Vermont and 30% of known species that occur in New England. Many sites had been affected by earthworms. Those that showed the most damage were invaded by *Lumbricus terrestris* (Night Crawler) and *Amynthas spp.* (Snake Worm species). In 2015, there were strong effects of *L. terrestris* and *A. spp*. on plant cover, species richness and maple seedlings. However, in 2016 we found little evidence that invasion made a difference in plant community and seedling recruitment. We attribute this to the effect of the drought that afflicted most of New England during the summer of 2016 when the monitoring was done. Most seedlings in earthworm affected stands were first year seedlings that are still vulnerable to deer browsing. In the absence of effective earthworm controls, care should be taken to protect uninvaded sites.

Spruce Grouse Habitat Ecology in Maine's Commercially Managed Acadian Forest

Stephen Dunham[1,2], Erik J. Blomberg

[1]Cooperative Forest Research Unit
[2]University of Maine

Figure 29. Example of ideal spruce grouse stands. The top image shows two grouse around an opening in an otherwise uniform conifer stand. The bottom image shows a patchier mid-successional stand.

Spruce grouse (*Falcipennis canadensis*) inhabiting Acadian forest of the northeastern United States are at the southern extent of their range and are listed as state-endangered in two (New York and Vermont) of the four states where they persist in the northeast. Often assumed to be associated with mature, unharvested forests in this region, few studies have addressed spruce grouse habitat ecology in commercially managed forests. We investigated occupancy and abundance of male spruce grouse during the breeding season and patterns of within stand-scale habitat selection of spruce grouse hens during the brood-rearing season in the commercial forests of northcentral Maine. Patterns of occupancy and abundance by male spruce grouse were examined by surveying 30 stands during each breeding season (May-June) in 2012-2014. Areas surveyed represented four common forest harvest histories including regenerating clearcut, pre-commercially thinned, selection harvest, and mature unharvested conifer stands. Probability of detection given occupancy was 0.61, and the probability of occupancy varied by successional stage from 0.37 to 0.77. Across our study area, individual male grouse had a probability of detection of 0.24 and the abundance of male grouse also varied by successional stage from 0.67 to 2.75 grouse per surveyed stand. Based upon the covariates included in the models, both occurrence and abundance of breeding male spruce grouse were highest in mid-successional, moderately dense, conifer-dominated stands that have experienced intensive forestry practices. We investigated within stand-scale (i.e., 3rd-order selection) habitat selection by female spruce grouse during the brood-rearing season (June-October) in 2012-2014 by tracking 30 radio-marked hens captured in 12 stands. We used general linear mixed models to construct resource selection functions to compare use to availability for each hen. Female spruce grouse selected for abundant low vegetation structure (<0.5m), lowest tree branches 3-9 m above ground, and for tree densities <1000 /ha. We also developed home range estimates based on 80% fixed kernel utilization distributions to determine appropriate scales for managing brood season habitat. We estimated fixed kernel home ranges for 27 hens, and observed an average home range area of 37.7 ha (SE = 23.9 ha). Spruce-fir forests in the region have declined in recent years and are predicted to decline further under all future climate scenarios. Currently, the conditions selected for by spruce grouse occur predominantly in northern Maine within stands with a past history of clearcutting followed by post-harvest treatments of herbicide and/or pre-commercial thinning to suppress hardwood regeneration. Our results suggest substantial opportunities to provide for habitat needs of spruce grouse within commercial forests managed for conifer regeneration following stand replacing harvests.

Watershed-Scale Conservation, Restoration and Management in The Maine Woods

David Publicover[1]

[1]Appalachian Mountain Club

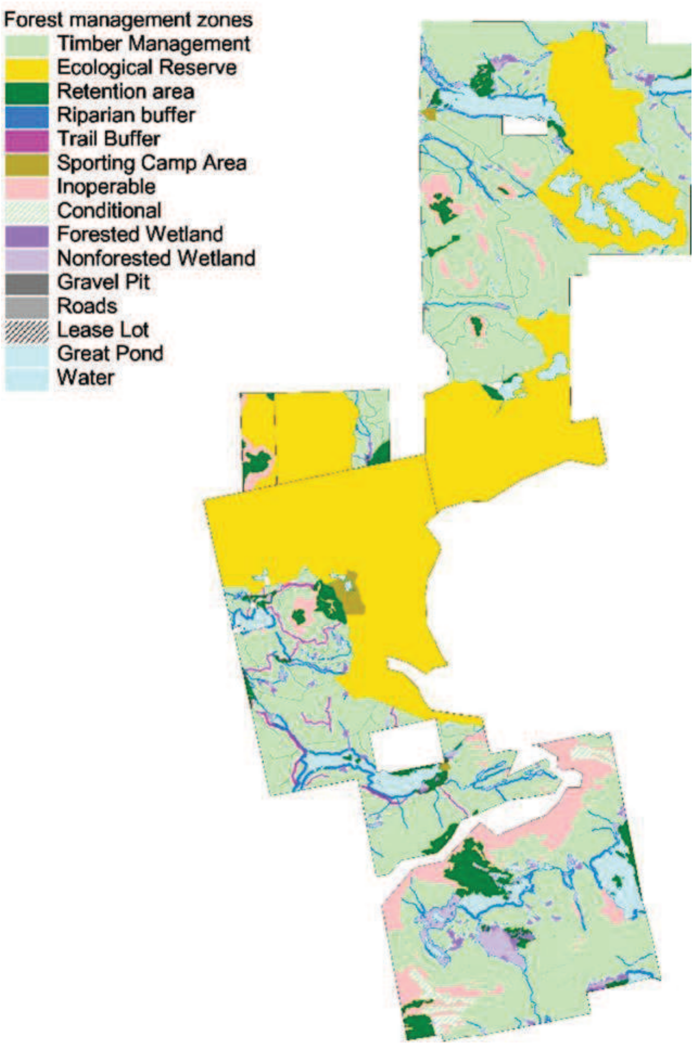


Figure 30. Forest management zones surrounding the west branch of the Pleasant River in Maine.

The Appalachian Mountain Club's Maine Woods Initiative encompasses 70,000 acres of forestland east of Moosehead Lake purchased from commercial timber companies since 2003. The land is managed for a combination of backcountry recreation, sustainable forestry, habitat conservation and outdoor education. The property is encumbered by five conservation easements held by the Maine Bureau of Parks and Lands, The Nature Conservancy and the Forest Society of Maine and has been certified by the Forest Stewardship Council.

AMC's property contains the headwaters of two rivers and several lake and stream systems. Of particular note is the West Branch of the Pleasant River, one of Maine's most significant wild brook trout fisheries. The river was described by the Maine Rivers Study as "one of the most primitive areas in the state" and is a Nature Conservancy priority portfolio aquatic ecosystem. Of the 32,000-acre watershed upstream of Gulf Hagas, 77% lies within AMC's ownership. In 2003 just 11% of this watershed was conserved; today 94% is conserved, with 64% in permanent ecological reserve.

In cooperation with the USDA Natural Resources Conservation Service, AMC has undertaken a major effort to improve aquatic habitat connectivity across its property. Over the last five years AMC has removed 19 barrier culverts and reconnected 22 miles of tributary headwater streams to their main stem rivers. These streams provide important cold-water spawning habitat for brook trout and Atlantic salmon.

About half of AMC's property is designated for active timber management. The long-term goal is to promote the restoration of mature multi-aged forests that more closely reflect the natural composition and structure of the region's forests. A strong emphasis is put on the retention and recruitment of large old trees and large woody debris. Complete overstory removals and even-aged management are avoided.

AMC's management incorporates many of the climate change adaptation principles set forth in the USFS publication *Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers*. In addition to landscape-level conservation and restoring aquatic connectivity, these include improving forest road stability and drainage structures, retaining a diverse species mix during harvesting, and retaining mature white pine as seed source. (This species is currently limited on the property but is expected to increase in a future warmer climate.) AMC has also completed a verified forest carbon offset project with the Climate Action Reserve on a portion of the property.

AMC's activities are monitored annually by the easement holders and FSC. Long-term changes in forest composition and structure will be monitored through period timber management and carbon project inventories. AMC is a cooperator in the Maine Forest Service statewide spruce budworm monitoring program and has assisted with the USGS Appalachian Trail Mega-Transect monitoring project.

Image and Photo Credits

Cover Photo

"Forested Stream" by Rich Kirn

Introduction

"Great Blue Heron Flying" by John Truong

Plenary Sessions

All photos from speaker presentations with the following exceptions:

"Karl Honkonen" by Glenn Rosenholm can be found online at http://archive.constantcontact.com/fs133/1104192170979/archive/1117189673802.html#home

Riparian Forest Buffers online at http://dnr.maryland.gov/forests/Pages/publications/buffers.aspx

"Toni Lyn Morelli" online at https://portals.iucn.org/congress/es/update/11917

"Colin Beier" online at http://nsrcforest.org/researcher/colin-beier

"Welcome to the FEST Project" banner online at http://www.forestecoservices.net/

Summary of Working Sessions

Habitat Restoration Solutions logo online at http://habitatrestorationvt.com/

Lewis Creek Association logo online at http://www.lewiscreek.org/

"Wetlands and Foliage" (left photo) "Wetland and Open Water" (right photo) by Charlie Hohn

Contributed Abstracts Session

All photos from speaker presentations with the following exceptions:

Figure 22. Vermont hardwood-coniferous forest (Photo credit John Truong)

Earthworm. By Flickr user Dodo-Bird. Online at https://www.flickr.com/photos/dodo-bird/477499086 and reproduced under a Creative Commons BY 2.0 License (https://creativecommons.org/licenses/by/2.0/)

Appendix: Agenda for 2016 Conference

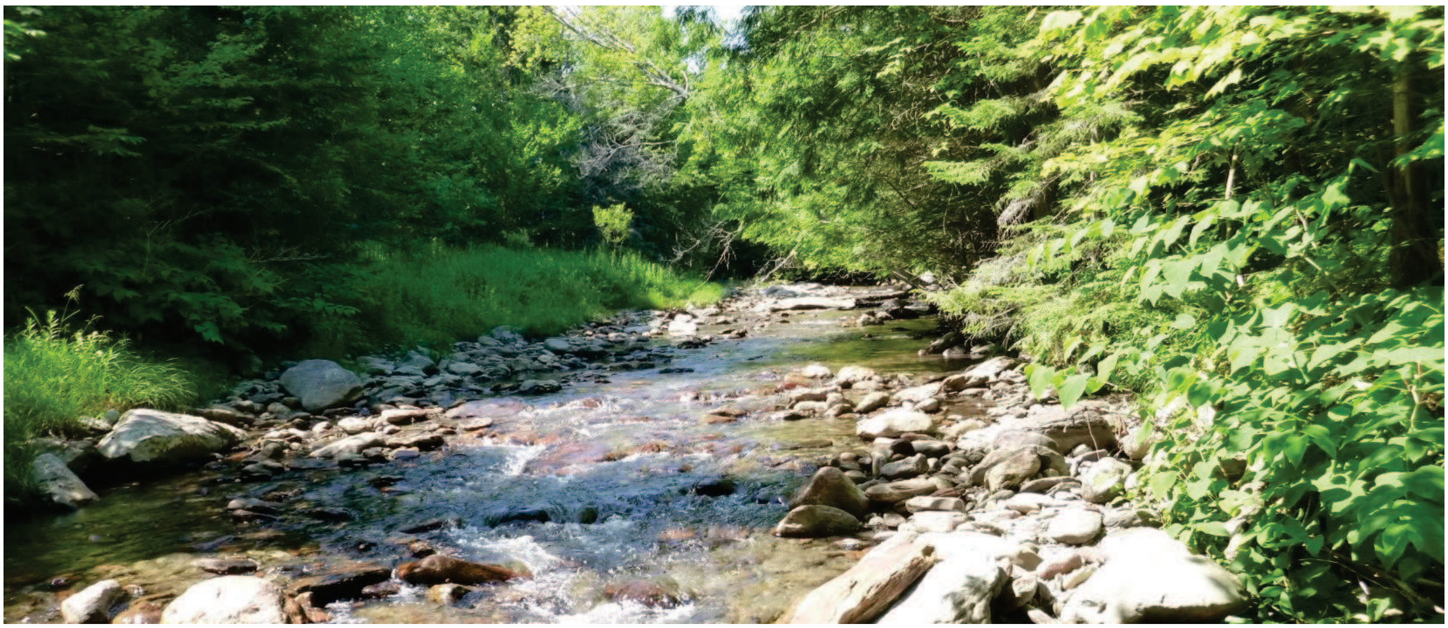
For informational purposes, the agenda from the conference is reproduced on the following page. It is also available online at http://www.uvm.edu/vmc/annualMeeting/2016/agenda

2016 Vermont Monitoring Cooperative Conference

Healthy Forests, Healthy Watersheds

Davis Center, University of Vermont

Friday, December 2, 2016



Vermont Monitoring Cooperative

The University of Vermont
THE RUBENSTEIN SCHOOL
OF ENVIRONMENT AND NATURAL RESOURCES

VERMONT
AGENCY OF NATURAL RESOURCES

About the Vermont Monitoring Cooperative

For over 25 years, the Vermont Monitoring Cooperative has brought together practitioners from a range of disciplines and institutions to work together on monitoring and assessing forested ecosystems. The result is one of the largest and longest consistent records of forest ecosystem health in the country.

The primary mission of the VMC is to "**serve as a hub of forest ecosystem research and monitoring efforts … to facilitate an understanding of long-term trends, annual conditions and interrelationships of the physical, chemical, and biological components of forested ecosystems**"

The History of the Vermont Monitoring Cooperative

Established in 1990 as a partnership among the USDA Forest Service, the State of Vermont Agency of Natural Resources and The University of Vermont (UVM), the mission of the Vermont Monitoring Cooperative (VMC) mirrors and builds upon the priorities of these partners. The VMC serves as a hub to facilitate collaboration among federal, state, non-profit, professional and academic institutions towards ongoing monitoring of forested ecosystems across the region and an improved understanding of forested ecosystems in light of the many threats they face.

The Services of the Vermont Monitoring Cooperative

The VMC staff supports the activities of a much larger network of actively engaged collaborators across governmental, academic, research and non-profit organizations. VMC staff work with these collaborators to provide:

- Coordination and facilitation of monitoring and research activities across organizations, disciplines and state boundaries;
- Data support including: retrieval, archive, management, sharing, analysis and synthesis;
- Coordination and support of long-term ecosystem monitoring;
- Yearly syntheses of key ecosystem components, providing up-to-date assessments of current forest condition as well as long-term trends;
- An Annual Conference where ecosystem professionals come together for a day of sharing, learning and networking across disciplinary and organizational boundaries.

Getting Involved with the Vermont Monitoring Cooperative

Interested in getting involved? The VMC has numerous committees and activities that could use your support, and we would love to hear from you! Contact Jim Duncan (james.duncan@uvm.edu) if you would like to learn more.

About the 2016 Conference

This year, the theme for the conference is:

Healthy Forests, Healthy Watersheds

Forests are critical to maintaining healthy, functioning ecosystems, with particular importance in regulating the flow of water, protecting water quality, and providing valuable ecological services and economic benefits including carbon sequestration, wildlife habitat, and forest products. This year we focus on forests at the watershed scale, with a particular lens on managing forests to maintain these critical functions across the landscape.

Schedule at a glance

8:45 – 9:00	Welcome
9:00 – 9:15	Update on the State of the Cooperative
9:15 – 10:45	Plenary: Forest Management and Watershed Condition
11:00-12:00	Contributed Talks Session 1
12:00 – 1:00	Lunch
1:00 – 2:20	Contributed Talks Session 2
2:30 – 4:00	Working Groups
4:00 – 5:00	Poster Session and Social Hour

The morning plenary will feature an array of presenters from various disciplines speaking to the relationship between forests and watersheds, including metrics or strategies employed to inform forest management and how these influence watershed condition. A question-and-answer panel made up of the speakers will allow the morning speakers to explore these topics in more depth. As in past years, the afternoon will be devoted to concurrent sessions where collaborators from across the region can present their most recent work, a variety of working group sessions convened by members of our professional community, and a poster session and social hour.

A **special thank you to our Conference Facilitators** Alexandra Kosiba, Julia Runcie, Rebecca Stern, Emma Tait and John Truong for their help in moderating our contributed talks sessions.

News from the Cooperative in 2016

VMC Goes Regional - Several Projects in Neighboring States Underway

VMC has been expanding its cooperators network with forest health data rescue in collaboration with the NY Department of Environmental Conservation, data archive and publication support for the Environmental Monitoring and Management Alliance, aggregation of Massachusetts monitoring and research data and more.

VMC Data Management Portal Now Open to All

Built on the latest standards for ecological and scientific data sharing, the VMC portal is now available to host and share data on the forested ecosystems of the region.

More information at http://www.uvm.edu/vmc/news/item/76

The Vermont Monitoring Cooperative Long-Term Monitoring Update – 2015

A review of long term trends in thirteen key areas affecting regional forest ecosystem health, updated for 2015. Available online at http://www.uvm.edu/vmc/about/annual_report/2015

Cover Photo – "Forested Stream" by Rich Kirn

Agenda

8:00 – 8:45 Registration *(Livak Fireplace Lounge. Coffee and poster setup in Sugar/Silver Maple)*

8:45 – 9:00 Host's Welcome and Introductory Remarks *(Sugar/Silver Maple)*

Jennifer Pontius, *Principal Investigator, Vermont Monitoring Cooperative*

9:00 – 9:15 Update on the State of the Cooperative *(Sugar/Silver Maple)*

VMC Director Jim Duncan will present a brief update on the Vermont Monitoring Cooperative network, structure, services and future.

9:15 – 10:45 Plenary Session

Forest Management and Watershed Condition

The plenary will seek to address the current state of understanding about the links between forest management and watershed-level health. Three speakers will give focused, 15-minute talks exploring the relationship between watershed-level indicators of ecosystem condition and how forest management and planning is adapted in response to changes in these indicators.

Moderator: Dan Lambert, High Branch Conservation Services

Karl Honkonen *Watershed Forester* *USFS Northeastern Area* *State and Private Forestry*	Karl Honkonen will speak on science and practice of riparian forest buffer restoration.
Toni Lyn Morelli *Research Ecologist* *DOI Northeast Climate* *Science Center*	Toni Lyn Morelli will speak to an emerging initiative that aims to co-develop management-relevant research to improve invasive species management in the face of climate change.
Colin Beier *Associate Professor* *SUNY College of* *Environmental Science and* *Forestry*	Colin Beier will speak on the use of monitoring data to measure how forest management, land use change, pollution, and other factors synergistically impact the multiple benefits provided by northern forests.

10:45 – 11:00 Coffee Break *(Sugar/Silver Maple)*

11:00 – 12:00 Contributed Talks Session 1 *(Rooms listed below)*

Learn about new and ongoing research, monitoring, conservation and outreach initiatives related to the forested ecosystem through several concurrent sessions of presentations.

Abstracts are available at the registration desk.

Contributed Talks Session 1 Schedule

Time	**Watershed Management 1** *Moderator:* Alexandra Kosiba *Room*: Frank Livak	**Watershed Management 2** *Moderator*: John Truong *Room*: Silver Maple	**Monitoring and Assessment 1** *Moderator*: Emma Tait *Room*: Mildred Livak
11:00 to 11:20	The Role of Forests in Maintaining Water Quality in the Lake Champlain Basin *Kristen Underwood, University of Vermont*	Defining forest health in managed forests *Sandy Wilmot, Vermont Department of Forest, Parks and Recreation*	Regional Environmental Monitoring Through Collaborative Research at the Cary Institute of Ecosystem Studies in Millbrook New York *Vicky Kelly, Cary Institute of Ecosystem Studies*
11:20 to 11:40	Regeneration responses to management for old-growth characteristics in northern hardwood-conifer forests *William Keeton, RSENR, University of Vermont*	Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape *Eric Sorenson, Vermont Fish and Wildlife Department*	Continuous Forest Inventory across Vermont State-owned Land in the Northeast Kingdom *Emily P. Meacham, Vermont Department of Forests, Parks, and Recreation - State Lands Program*
11:40 to 12:00	Watershed-scale conservation, restoration and management in the Maine Woods *David Publicover, Appalachian Mountain Club*	Strategies for Reducing Phosphorus Loading and Sedimentation from Forestry Operations in Vermont *Gary Sabourin, Vermont Department of Forests, Parks and Recreation*	Bioassessment in Vermont's Forested Wetlands: Past, Present, and Future *Charlie Hohn, Vermont Agency of Natural Resources, Wetlands Program*

12:00 – 1:00 Lunch *(Sugar/Silver Maple)*

1:00 - 2:20 Contributed Talks Session 2 *(Rooms listed below)*

Learn about new and ongoing research, monitoring, conservation and outreach initiatives related to the forested ecosystem through several concurrent sessions of presentations.

Abstracts are available at the registration desk.

Contributed Talks Session 2 Schedule

Time	**Landscapes** *Moderator:* Rebecca Stern *Room*: Frank Livak	**Wildlife** *Moderator*: Emma Tait *Room*: Chittenden	**Monitoring and Assessment 2** *Moderator*: Julia Runcie *Room*: Mildred Livak	**Drivers of Change** *Moderator*: Alexandra Kosiba *Room*: Jost
1:00 to 1:20	Modeling hemlock woolly adelgid risk and impacts of presalvage harvesting on carbon stocks in northern hemlock forests *Jennifer Pontius, USFS NRS and UVM*	Moose in Northern New England - Populations, Forest Management, and Climate Change *Peter Pekins, University of New Hampshire*	The Environmental Monitoring and Management Alliance (EMMA) and White-tailed Deer Monitoring for Management *Lynn Christenson, Vassar College*	Identifying species at risk from nitrogen deposition in forests in the northeastern U.S.: a geospatial analysis using exceedance of critical loads *Linda H. Pardo, USDA Forest Service, Northern Research Station*
1:20 to 1:40	E 15,001 Trees and Counting *Elise Schadler, Vermont Urban & Community Forestry Program*	Spruce Grouse Habitat Ecology in Maine's Commercially Managed Acadian Forest *Stephen Dunham, Cooperative Forest Research Unit; U. of Maine*	Defining and Targeting High Flows *Bill Hoadley, South Chittenden River Watch*	Do Invasive Earthworms Affect Maple Regeneration? *Josef H. Gorres, Plant and Soil Science, University of Vermont*
1:40 to 2:00	The Application of LiDAR to Watershed Management on the White Mountain National Forest *Landon Gryczkowski, White Mountain National Forest*	Rusty Blackbirds in the Northern Forest: Breeding Season Status and Habitat Associations at Local and Landscape Scales *Stacy McNulty, SUNY College of Environmental Science and Forestry*	Changing tree species distributions: a 30 year investigation into spatiotemporal trends *David Gudex-Cross, RSENR University of Vermont*	Bioaccumulation and Trophic Transfer of Methylmercury in Wood Frogs and Spotted Salamanders in Vermont Vernal Pools *Steve Faccio, Vermont Center for Ecostudies*
2:00 to 2:20	30 years of forest conversion in the Northeast: historical patterns and future projections *Alison Adams, University of Vermont*	Estimating the source of American martens (*Martes americana*) in Vermont and their genetic structure in the northeastern United States *Cody Aylward, University of Vermont*	Photopoint Monitoring in the Adirondack Alpine Zone *Julia Goren, Adirondack Mountain Club Summit Steward Program*	The Monkton Amphibian Underpass *Jim Andrews, Vermont Reptile and Amphibian Atlas*

2:20 – 2:30 **Coffee Break** *(Silver Maple)*

2:30 - 4:00 **Working Groups** *(Rooms listed below)*

Proposed, organized and run by meeting participants, this time allows for more structured networking and communication among current and potential collaborators.

A new GIS tool for assessing forest risk from nitrogen deposition and climate change: hands-on workshop -By Invitation-
Organizer: Linda H. Pardo, USDA Forest Service, Northern Research Station
Room: Aiken 101 (building next door to Davis Center)

Fine-Tuning a Wetlands Rapid Assessment Protocol -Open to All-
Organizer: Charlie Hohn, Vermont Agency of Natural Resources - Wetlands Program
Room: Chittenden

Forest disturbance in the Northeast US: Synthesizing field data and forest health aerial surveys -Open to All-
Organizer: Garrett Meigs, University of Vermont
Room: Frank Livak

How to best monitor for efficacy of invasive plant control efforts -Open to All-
Organizer: Robert Hyams, Lewis Creek Association, Habitat Restoration Solutions, LLC
Room: Jost

Vermont Water Monitoring Council Meeting -Open to All-
Organizer: Neil Kamman, VTDEC - Watershed Management Division
Room: Sugar Maple

VMC Management Portal Overview -Open to All-
Organizer: Mike Finnegan, Vermont Monitoring Cooperative
Room: Silver Maple

4:00 – 5:00 **Posters & Social Hour** *(Sugar/Silver Maple)*

Enjoy conversation, posters and a cash bar at the end of the day. A list of posters can be found below.

Working Group Descriptions

A new GIS tool for assessing forest risk from nitrogen deposition and climate change: hands-on workshop -By Invitation-

Organizer: Linda H. Pardo, USDA Forest Service, Northern Research Station

The GIS-based tool, Nitrogen Critical Loads Assessment by Site (N-CLAS) evaluates the impact of multiple stressors (N deposition and climate change) simultaneously for species of management concern on public and private forest lands. In addition to calculating species-specific critical loads, N-CLAS is designed to take into account the impact of site abiotic factors on the response of trees to N deposition. Application of N-CLAS across the northeastern U.S. allows us to evaluate which areas and tree species are most susceptible to impacts from N deposition. N-CLAS can determine the critical load and exceedance for individual tree species or all the species present. N-CLAS also provides information about the % of the area where deposition is in exceedance of the critical load and the % area by species at risk at any given deposition level. We are incorporating climate change scenarios in order to explore the interaction between climate change and nitrogen deposition. Thus, we will also be able to determine the fraction of the region that is susceptible to detrimental impacts of N deposition under projected climate scenarios. Use of this tool provides resource managers with a simple way to incorporate the current state-of-the-science knowledge into their planning and management decisions. This workshop will teach users how to work with this new tool to meet their resource management needs.

Room: Aiken 101 (building next door to Davis Center)

Fine-Tuning a Wetlands Rapid Assessment Protocol -Open to All-

Organizer: Charlie Hohn, Vermont Agency of Natural Resources - Wetlands Program

The Vermont Wetlands Program is updating a rapid wetland assessment protocol which will be made available to use for the public and any stakeholders interested in helping build our knowledge of Vermont wetlands. Possible target groups include conservation commissions, land trusts, land management agencies, UVM students, motivated citizen scientists, and the different branches of the Vermont Agency of Natural Resources - basically all attendees of the VMC. Data will be used to track the status of wetlands throughout the state, approximate the data that would be collected by more intensive surveys, and help select sites for these more detailed surveys. Come help us update this protocol so that it will be useful for the widest audience possible! We anticipate that this is something all of you would find helpful for your own use as well as to help build knowledge within the Wetlands program - and we know if you are a part of the protocol planning process, the methodology will be more useful to you!

Room: Jost

Forest disturbance in the Northeast US: Synthesizing field data and forest health aerial surveys -Open to All-

Organizer: Garrett Meigs, University of Vermont

This working session will focus on identifying methods, data, and outputs for linking field-based observations of forest change with aerial detection surveys in the northern forest region. The organizers will present the current status of an initiative to combine forest health aerial surveys from NY, VT, NH, ME, and MA with research data funded by the Northeastern States Research Cooperative. Participants will be asked to review the initial work to date, suggest additional field data for inclusion, and explore ways of linking forest health and disturbance data at multiple spatial and temporal scales.

Room: Frank Livak

How to best monitor for efficacy of invasive plant control efforts -Open to All-

Organizer: Robert Hyams, Lewis Creek Association, Habitat Restoration Solutions, LLC

There are a number of initiatives to control Exotic/Invasive plant populations that impact a range of natural communities within Vermont. Funding, whether federal, state, or NGO, typically covers cost of treatment for a calendar year. I believe little work is being conducted to determine efficacy outside of the first season. As a result, we are at risk of spending limited dollars and increasing chemical burden without empirical evidence to justify the means.

Room: Chittenden

Vermont Water Monitoring Council Meeting -Open to All-

Organizer: Neil Kamman, VTDEC - Watershed Management Division

The Vermont Water Monitoring Council serves to complement VMC's statewide work by convening a broad stakeholder group for whom the availability of water quantity and quality data is of significant interest. During this session, the Council will meet. Invited content is envisioned to include: 1) Flood forecasting models for Lake Champlain; 2) A sneak preview of modeling tools available to estimate phosphorus discharges from small-scale Lake Champlain catchments; 3) Updates to measured long-term phosphorus loads to Lake Champlain; 4) new developments in the LaRosa Partnership Program; 5) Introduction to the Clean Water Network; 6) Roundtable of updates from monitoring groups.

Room: Sugar Maple

VMC Management Portal Overview and Training -Open to All-

Organizer: Mike Finnegan, Vermont Monitoring Cooperative

Over the past year, several significant changes have been incorporated into the VMC's Management Portal, a web interface that enables researchers to manage their projects and datasets, while providing a public-facing side, promoting discoverability and collaboration by end users. In this Working Session, the first half hour will be spent walking through a typical use case, paying particular attention to the new features of the portal and describing the benefits they provide. The expected outcome is that participants will be chomping at the bit to use the new system! Fortunately, the remaining hour will be dedicated to helping those participants migrate their data into the portal with VMC staff's assistance available. If you plan to attend and have a dataset you wish to process, please bring it on a USB Flash drive, preferably in Comma Separated Values (CSV) format.

Room: Silver Maple

Poster Session Titles and Presenters

4:00 – 5:00, Silver Maple

Acoustic and visual monitoring of the spring phenology of snow, leaves, bugs, and birds on Mount Mansfield - John D. Lloyd, *Vermont Center for Ecostudies*

Characterization of immune genetic diversity in APOBEC3H in the Vermont population of Eastern bobcat (*L. rufus*) - Meghan Lavoie, *Saint Michael's College*

Continued Expansion of the Vermont Monitoring Cooperative's Forest Health Monitoring Network - John Truong and Kirsti Carr, *Vermont Monitoring Cooperative, University of Vermont*

Critical loads of N in Class I Areas: species and sites at risk from exceedance - Molly Robin-Abbott, *USDA Forest Service*

Key Findings from the City of Winooski's I-tree Inventory: An assessment of an urban canopy's Ecosystem Services - Holly Kreiner, *Winooski Natural Resources Conservation District*

Lake Champlain Sea Grant - Elissa Schuett, *UVM*

Landscape scale assessments of forest productivity: methods, patterns and trends - Jennifer Pontius, *USFS NRS and UVM RSENR*

Long-term biological monitoring of Ranch Brook, Stowe, Vermont - Michelle Graziosi, *Vermont Department of Environmental Conservation*

Mapping Tree Species across Northern New York and Vermont using Spectral Unmixing of Multi-temporal Landsat Imagery - David Gudex-Cross, *UVM RSENR*

Network Analysis for Watershed Management - Lindsay Barbieri, *University of Vermont, Rubenstein School for Environment and Natural Resources & Gund Institute of Ecological Economics*

Northeastern States Research Cooperative - Shari Halik/Elissa Schuett, *UVM*

The 2016 Impacts of Forest Tent Caterpillar in Vermont - Josh Halman, *Vermont Department of Forests, Parks and Recreation*

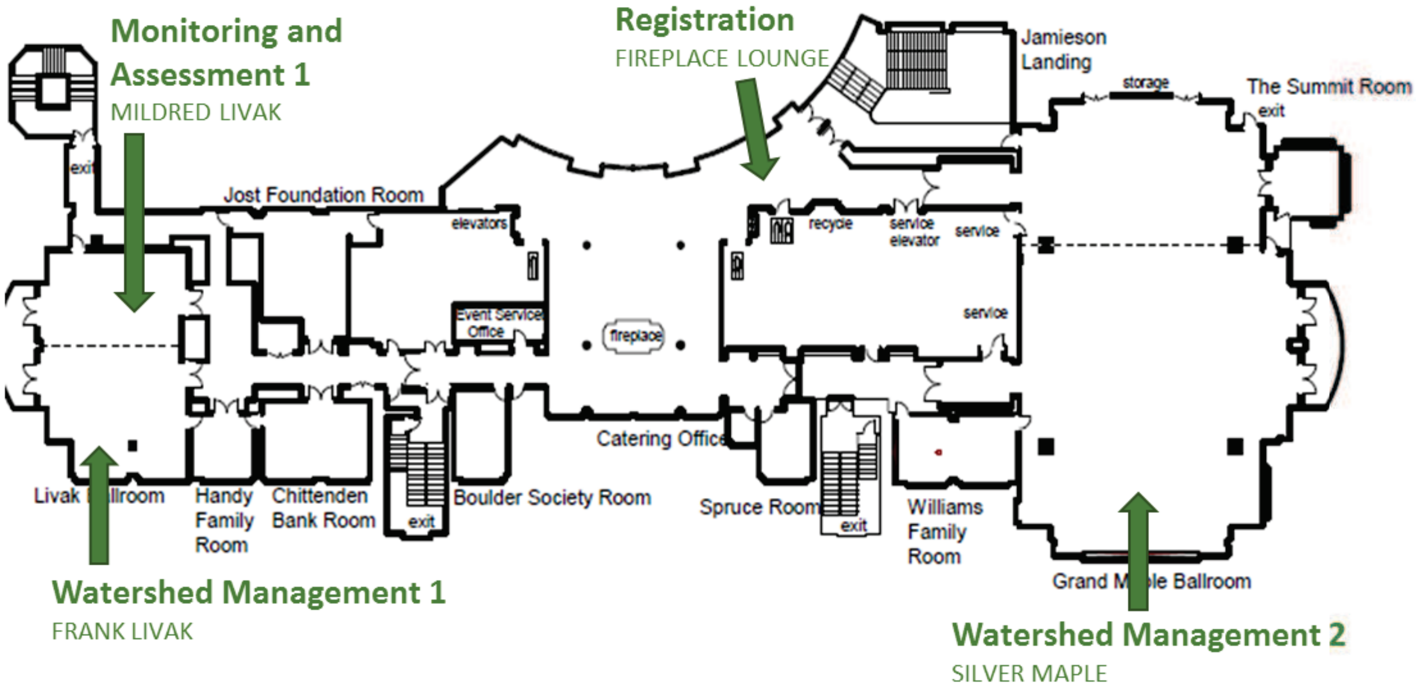
The Power of Communities: Investing in the future of healthy forests through invasive plant management and outreach - Elizabeth Spinney, *Vermont Department of Forests, Parks & Recreation*

Validation of a NN Weather Generator Methodology Based on North American Regional Reanalysis Historical Data - Rory Cummings, *Community College of Vermont / Vermont EPSCoR RACC Grant (UVM & SMC).*

Vermont Snowmobiling: Adaptation to Climate Change - William Valliere, *University of Vermont*

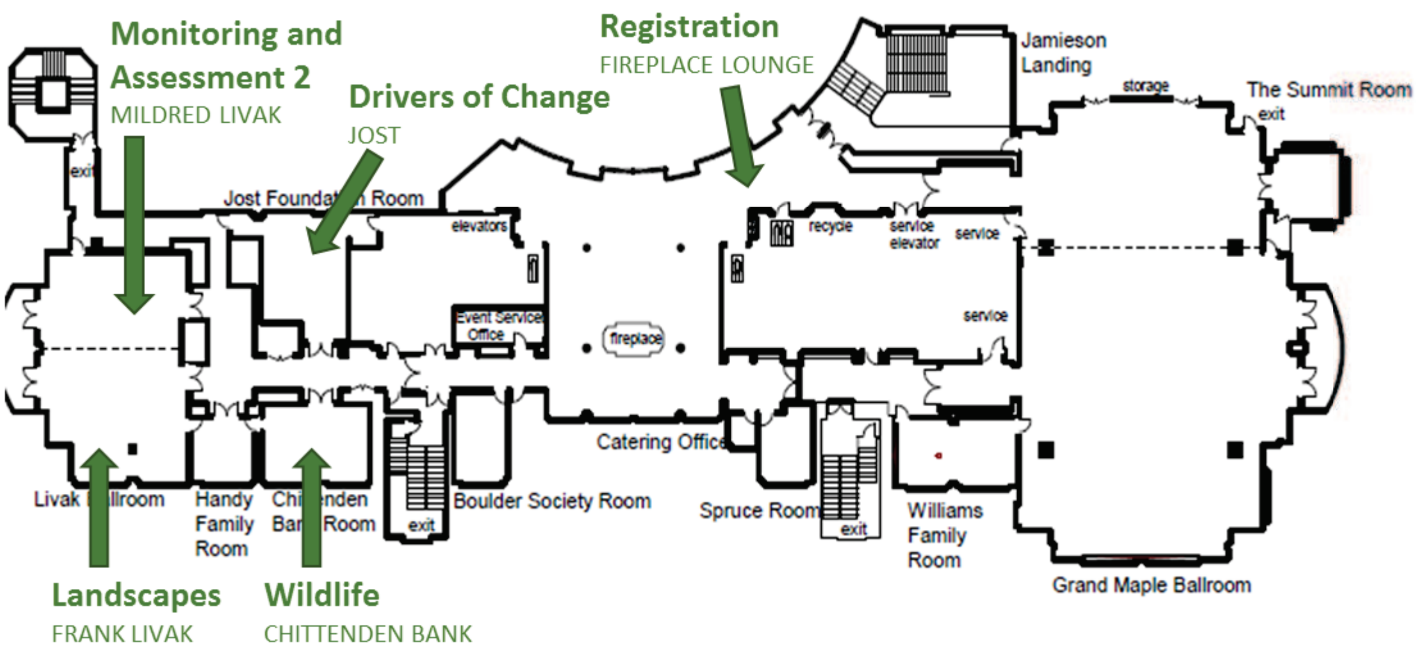
Room Assignments for Contributed Talks Session 1

11:00 – 12:00

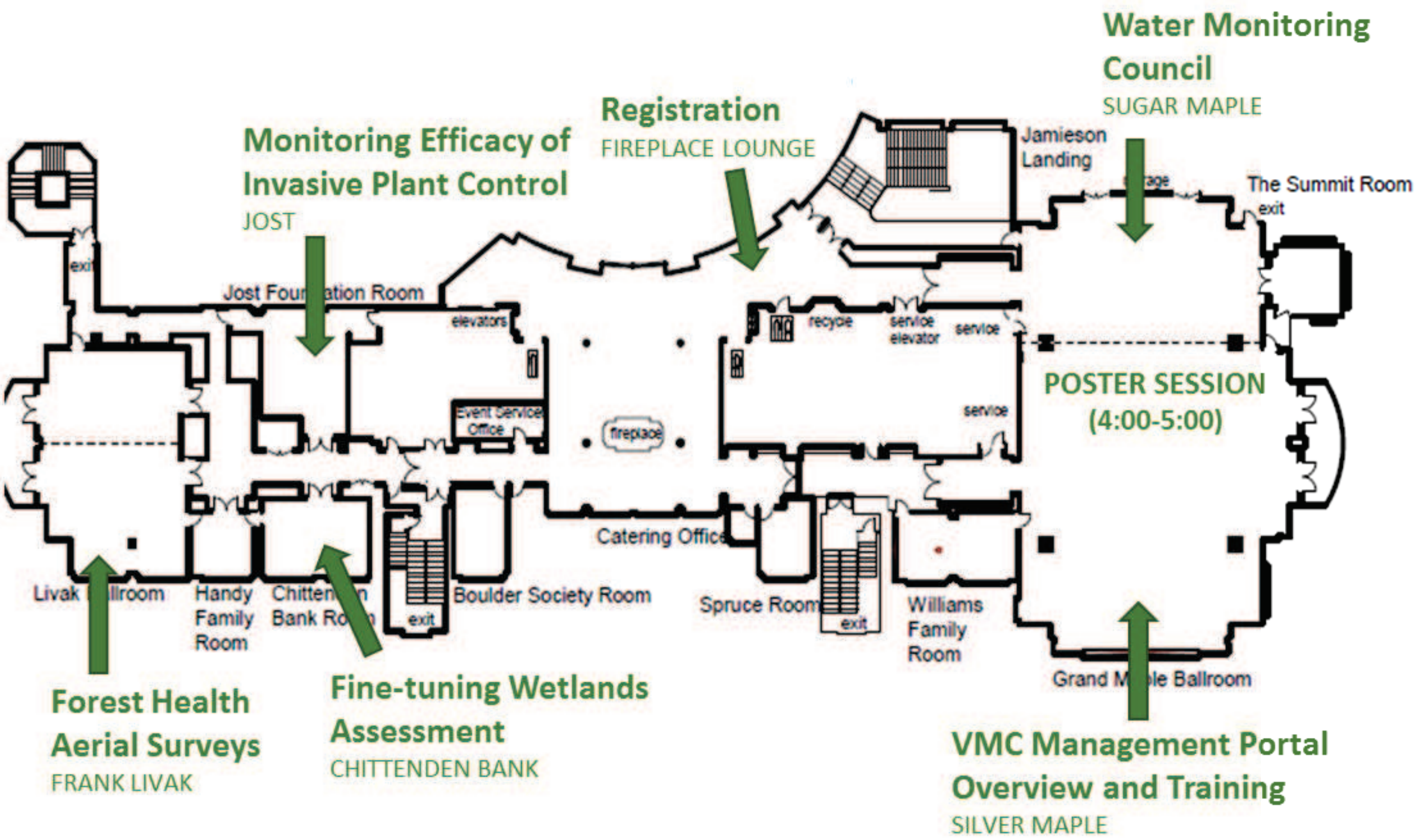


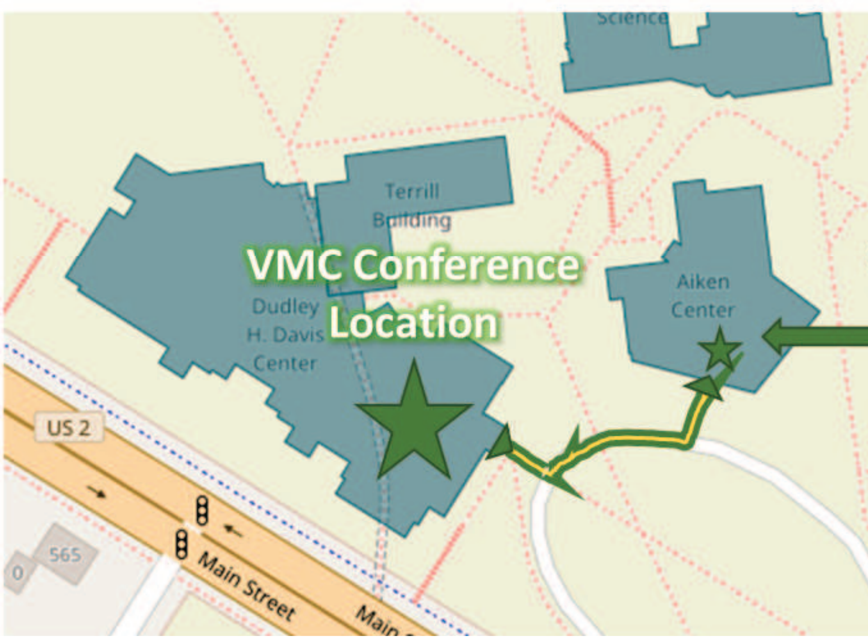
Room Assignments for Contributed Talks Session 2

1:00 – 2:20



Room Assignments for Working Groups and Poster Session
2:30 – 5:00





GIS Tool for Assessing Nitrogen Deposition Risk
AIKEN 101
Walk in the door, go down the stairs, turn left and go to computer lab on your left