Forest Ecosystem Monitoring Cooperative 2020/2021 Work Plan

Last updated: June 10, 2019

The Forest Ecosystem Monitoring Cooperative 2020/2021 Work Plan is intended to guide FEMC staff in supporting the Cooperative for the calendar years of 2020 and 2021. This document summarizes key activities FEMC staff will undertake to support key Cooperative programs in those two years, as well as a brief summary of the ongoing core programmatic activities supporting the mission of the FEMC. It specifically describes the final regional work plan elements developed in consultation with the FEMC Steering Committee and state partners from New Hampshire, New York and Vermont. The Massachusetts' Forest Reserve Science Advisory Committee will provide additional input on these topics in late June, 2019.

The activities in this work plan are funded by the USDA Forest Service through an appropriation in the federal fiscal year 2019 budget. The University of Vermont, the Vermont Department of Forests, Parks and Recreation, the Massachusetts Department of Conservation and Recreation, and cooperating partners provide matching funds. This year represents an expansion in budget, and thus an expansion in work. The FEMC Steering Committee has recommended ramping up expenditures over two years (2020 and 2021), and this work plan is intended to meet that goal.

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STATES INCLUDED IN THE COOPERATIVE

With the increased budget, the Steering Committee recommends working with the larger seven-state region of New England and New York to include in regional synthesis efforts and completion of requested state-specific projects. This year represents the first year of attempting to work directly in Rhode Island and Connecticut, and a planned reengagement with Maine in a more formal capacity, made possible by the expanded 2019 expanded budget. If any state(s) chooses not to engage, the Steering Committee will reprogram the funds to deepen the regional and state projects described below.

SUMMARY OF THE FEMC WORK PLAN STRUCTURE

Each year the FEMC allocates it budgets and associated efforts in three distinct ways:
1) **Regional Projects**: Leading synthesis efforts around pressing regional forest health issues identified and selected through consultation with state partnership committees and the FEMC Joint and Steering Committees;
2) **State Sprint Projects**: Delivery of state-specific projects identified by state partnership committees to address needs that cannot currently be filled by state agencies and partnering organizations.
3) **Core Activities**: Maintenance of FEMC core activities such as data management, archiving and accessibility, and work building collaborative networks around key experts and stakeholders across the region.

SUMMARY OF REGIONAL PROJECTS

The regional work topics are developed each year in consultation with the leadership of the Cooperative, and refined during State Partnership Committee meetings. The four regional projects identified by FEMC Cooperators for work in 2020 and possible extension into 2021 are shown below. FEMC Committees will review the outcomes of this work at the end of 2020 and revise, if needed, the regional projects for 2021. Details on each project follow.

| Topic	Anticipated Products
Regional Project 1: **Forest Disturbance** Monitoring and communicating changes in forest disturbance	• Newly archived historical data on disturbance extent and timing from surveys and reports. • Expanded Northeastern Forest Health Atlas with additional disturbance patterns and drivers mapped and charted, and a longer temporal record. • White paper summarizing trends, monitoring gaps, recommendations to guide data collection moving forward, and model monitoring methods for tracking change in disturbance.
Regional Project 2: **Climate Metrics** Monitoring northeastern forest indicators for signs of climate-driven change	• Aggregation of dozens of monitoring datasets representing sensitive aspects of forest ecosystems in the Northeast. • Information portal showcasing the locations of existing monitoring of climate sensitive metrics and thresholds. • White paper summarizing current extent of key indicator monitoring in the region and model monitoring methods.
Regional Project 3: **Relevance and Currency** Maintaining and enhancing existing FEMC regional resources	Maintenance and/or enhancement of: • Northeast Forest Fragmentation Information Network (FragNet) • Northeastern Forest Health Atlas (NEFHA) • Continuous Forest Inventory Methods Assessment • Climate Connection • Existing state sprint projects
Regional Project 4: **Forest Health Monitoring** Expand and assess a network of permanent forest health monitoring plots	• Establishment and 2 years of measurements on 152 new forest health monitoring plots in participating states in the seven-state region • Report on baseline assessment and comparison to Forest Inventory and Analysis • Publicly-accessible data exploration and download capabilities within 3 months of end of field season.

REGIONAL PROJECT 1: MONITORING AND COMMUNICATING CHANGES IN DISTURBANCE REGIMES

Background

Disturbance patterns in northeastern forests are primarily driven by small scale wind events, pests and pathogens. But as climate continues to change there is concern that the severity and frequency of disturbance patterns may be changing, with cascading impacts on surface waters, soils and wildlife.

Key questions raised by partners in Committee meetings

- How much early successional forest is being created by disturbance, and how is that changing?
- What is the historical spatial footprint of disturbance, and how is that changing?
- How will changes in weather-driven disturbance (e.g. extreme precipitation) impact forest streams?
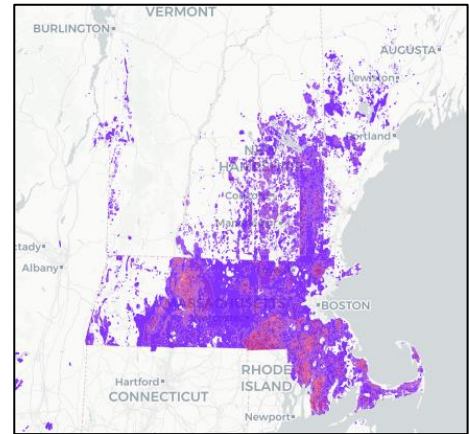
Project Objective

Through this project, FEMC will synthesize data region-wide to better understand how disturbance regimes are changing in northeastern forests, streams, lakes, soils, and wildlife, how these changes are connected to climate change and what monitoring gaps exist to track these changes. This will include a synthesis of observed and hypothesized changes attributable to climate change in our region and identification of key metrics to better explore and monitor the relationships between climate and disturbance patterns. The ultimate goal is to better understand the current state of knowledge on select disturbance regimes and the potential implications for sustainable management of forests across the region. Specifically, we will focus on disturbance by native and non-native insects and diseases, extreme rain and wind events, drought, fire and pollution deposition.

Outcomes

At the end of this project, Cooperative members will be able to:

- Access and visualize data and monitoring information in map and chart forms about the historical extent and timing of disturbances, specifically native and non-native insects and diseases, extreme rain and wind events, drought, fire and pollution deposition.
- Access interpretive information written by experts on how these regimes are expected to shift in the future and what the implications for management such as timber harvesting and early successional forest targets might be.
- Utilize a comprehensive gap analysis and summary of monitoring opportunities to fill those gaps and incorporate monitoring disturbance regimes into planning and assessment activities.

Key Products

- New archived historical data on disturbance extent and timing from surveys and reports
- Expanded Northeastern Forest Health Atlas with additional disturbance regimes mapped and charted, and a longer temporal record
- White paper summarizing trends observed in the data, gaps in monitoring, recommendations to state and federal land managers to guide data collection and study moving forward, and model monitoring methods for tracking change in disturbance.

Project Work Plan

- **Engage the Cooperative**
  - Distribute a survey instrument in late 2019 to the Cooperative to identify key questions, overlapping efforts and interested individuals.
  - Host a scoping and working meeting to refine the results of the survey, set the direction of the effort and identify the latest complementary efforts and key contributors. This meeting could take place at the 2019 FEMC Conference or as a separate workshop in in January 2020.
- **Aggregate sources of information and data** on disturbance across the region.
  - Literature review on disturbance regimes across the Northeast, specifically studies of changing disturbance patterns, studies on disturbance impacts on ecosystem function and projections of future disturbance regimes
  - Quantify historical evidence of disturbance such as insects, diseases, extreme events, droughts and fires by analyzing the content of past annual forest health reports developed by states and the USDA Forest Service
  - Expand historical record insect and disease disturbance in the Northeastern Forest Health Atlas:
    - Digitize additional data currently in paper format in New York and Vermont, and explore fixes to corrupt data in New Hampshire.
    - Add Connecticut and Rhode Island data to the Atlas.
    - Assess trends over time across the full region specific to the most common disturbance agents and newer agents of special concern.
  - Develop easy-to-use datasets summarizing historical trends and, where possible, spatial extents of key disturbance agents and responses to disturbance.
    - Historical and predicted data on extreme events.
    - Spatial and temporal data on deposition and pollution patterns.
    - Data on fire extent and severity
    - Forest stream macroinvertebrates that are sensitive to scouring from high flows.
    - Cold-water fisheries that are sensitive to rising stream temperatures.
    - Stream geomorphic condition from state and federal assessments.
- **Develop data visualization and information access tools** to capture temporal trends and spatial extent, allowing users to explore changing extent of a subset of disturbance types. This may include a map of historical data with an overlay of the trend over time for the region and locations of existing monitoring programs.
  - Update and expand the Northeastern Forest Health Atlas with synthesis maps on key disturbance types. Overlay figures of temporal trends in wind, defoliation / mortality, flooding, pathogens and historical spatial information from the forest health reports
  - Expand the Forest Health Atlas or create a companion tool to map historical flood data with overlay of regional hydrological data on flood extent, high flows and temporal data on fish and macroinvertebrate populations
  - Create an online monitoring "toolkit" for users to explore model methods for tracking changes in disturbance regimes and example implementations.
- **Convene a working group meeting** of regional experts in September 2020. This group will be charged to:

- o   Assess the data and tools and develop a summary of each of the target disturbance types.
- o   Develop online summary interpretive materials for web tool content.
- o   Conduct a gap analysis and recommendations to state and federal land managers to guide data collection and study moving forward.
- o   Contribute to a white paper on primary findings and management implications.
- **Revisit the outputs with FEMC Joint Committees** and determine Year 2 activities.

REGIONAL PROJECT 2: MONITORING NORTHEASTERN FOREST INDICATORS FOR SIGNS OF CLIMATE-DRIVEN CHANGE

Background

Forested ecosystems are generally resilient to change. But climate change could lead to conditions that push many species beyond "tipping points" beyond which recovery is unlikely. It remains unclear what those conditions (key metrics or limiting factors) may be or what the potential thresholds are beyond which recovery is impeded.

Key questions raised by partners in Committee meetings

- What is already known about climate-sensitive thresholds specific to the Northeast?
- How are abiotic thresholds (e.g. lake ice-out) and process thresholds (e.g. phenology) observed to be changing already?
- How will changing snow patterns affect forest management?
- What are the sentinel species (vegetation, wildlife) and processes that we should be monitoring, and where is that monitoring being done? Where is it missing?

Objective

This project will focus on identifying key ecosystem metrics to monitor and what to look for in monitoring data in order to improve our ability to identify possible tipping points within forested ecosystems. We will identify who is currently conducting these monitoring efforts, what monitoring protocols are available for replication, where there may be gaps in monitoring data, and how we can make data and monitoring information easily available so that land managers can have the most up-to-date information possible.

Outcomes

After this project, Cooperative members will be able to:

- Easily access sources of monitoring data and information on monitoring programs that provide insight on these key metrics.
- Explore an information portal on key findings of climate threshold studies to date and compendium of known climate thresholds for our region for living species and key processes such as ice-out and phenology.
- Read about the gaps we currently have in our knowledge of thresholds, or the monitoring needed to know when we're reaching them. This will include documentation of model monitoring protocols that could fill that gap.

Key Products

- Aggregation of dozens of monitoring datasets representing sensitive aspects of forest ecosystems in the Northeast.
- Information portal showcasing the locations of existing monitoring of climate sensitive metrics and thresholds.
- White paper summarizing current extent of key indicator monitoring in the region and model monitoring methods.

Project Work Plan

- **Engage the Cooperative** to identify broad range of possible indicators and accompanying thresholds, and current monitoring efforts.
    - o Deliver survey to ask "what monitoring do you know of that could identify tipping points in ecosystem components or processes?" This survey will build off of knowledge developed by NIACS and NECASC.
- **Identify current body of knowledge on thresholds and monitoring** with a literature review.
- **Convene a working group** of regional experts in Spring 2020. This group will be charged to:
    - o Review the Cooperative survey and the literature review outputs examine and summarize the monitoring and research work to date around climate indicators and thresholds.
    - o Identify a manageable subset of key indicators where thresholds do or might exist, balancing ideal indicators with those that already have a long-term data record.
    - o Contribute to a white paper on monitoring indicators for thresholds of impacts on forest ecosystems that includes:
        - ▪ a list of key data sets and indicators of change that are currently being monitored across the region.
        - ▪ specific thresholds or changes to trends that should be used to trigger an "alarm" for potential management action.
        - ▪ suggested monitoring activities that fill critical gaps to ensure we will not miss an indicator of ecosystem change.
- **Develop an information portal** on climate indicators and thresholds for forested ecosystems that communicates:
    - o The combined extent of climate metrics, thresholds and impact monitoring from Cooperative efforts, working group input and the literature review.
    - o Summary documentation on climate thresholds to ensure changes in ecosystem processes and function are identified as early as possible.
    - o Access to existing monitoring data sets with contextual information on their value for monitoring for ecosystem change.
    - o Monitoring methods framework – what to monitor, how to do it, what you will be able to understand if you do it, and how long it will take to have a monitoring record;
    - o Living portal of ongoing monitoring – can select individual thresholds or processes to show where monitoring is happening in the region and the protocols being used that people can easily grab and adapt, and then the people who take the model protocols and implement could submit their program back to FEMC to be included in the portal. This will also pull from and contribute back to other programs such as SHEDS that may have this type of data available already, and could connect to citizen science initiatives.
- Host a **special session at the 2020 FEMC Conference** to summarize key climate indicators, thresholds or indicators of change to watch for, model monitoring recommendations, and gaps in our knowledge.
- **Revisit the outputs with FEMC Joint Committees** and determine Year 2 activities.

REGIONAL PROJECT 3: MAINTAINING AND ENHANCING EXISTING FEMC REGIONAL RESOURCES

Background

FEMC has developed several tools and resources for its regional projects over the past two years. Continuing to maintain these resources and, in some cases, expand their functionality, was identified as a priority by the Joint Committees. Through post-meeting survey, the products detailed in the work plan below were identified as the most valuable for maintenance and/or expansion. The FEMC staff have proposed several ways to maintain and enhance these resources. Additional funding secured from the National Institute of Food and Agriculture (NIFA) will be used to dramatically expand the data component of the Continuous Forest Inventory Methods Assessment project.

Project Work Plan

Northeast Forest Fragmentation Information Network (FragNet):
- Additional extraction of information from documents and resources to identify the types of metrics used to quantify fragmentation, if available.
- Identify key potential datasets useful for monitoring fragmentation and make these accessible through FragNet.
- Conduct a survey of potential users or key contributors to identify additional needed functionality and implement.
- Explore options for expansion or integration with other existing efforts related to fragmentation in the region, such as the Staying Connected Initiative.

Northeastern Forest Health Atlas (NEFHA):
- Addition of data developed as part of Project #1.
- Addition of additional historical data from New Hampshire, New York and Vermont through digitization and standardization efforts.
- Expansion to include historical data from Connecticut and Rhode Island.
- Conduct additional outreach and training on the tool.

Continuous Forest Inventory Methods Assessment:
- Maintenance of web portal for exploring the outcomes
- Additional outreach on findings to date to promote interest and uptake
- Coordination of work under NIFA grant funds to expand the infrastructure

Climate Connection:
- Active searches to add new resources
- Conduct surveys and key informant interviews to identify needed additions and implement requested changes
- Better integrate with efforts of others, and potentially expand cataloging beyond portals focused on climate change impacts (Project #2)
- Conduct a vigorous outreach and engagement effort to promote the tool as a resource

Other existing state sprint projects and regional project:
- Maintain completed or ongoing sprint projects as requested by state partnership committees, e.g. updates to the New York and Vermont Forest Indicators Dashboards, additional analysis of harvesting in New Hampshire or data management for the Massachusetts Forest Health Monitoring project.
- Maintain or expand additional regional projects as directed by the Steering Committee.

Review all regional and state products with Joint Committees and determine Year 2 activities.

REGIONAL PROJECT 4: FOREST HEALTH MONITORING

Background

FEMC has been responsible for establishing, monitoring and interpreting annual forest health measurements in Vermont for 27 years. This monitoring network is designed to capture a range of tree health and structural stand metrics on a network of permanent plots that were selected to represent the larger population of forested ecosystems across the state. Annual measurements follow published methods that emphasize objective, quantitative measures in addition to traditional forest health metrics to enable detection of subtle decline symptoms as well as standardization and cross-walking with other forest health data sets. These plots provide substantial insight into annual fluctuations in tree and stand condition, and stand alone in the region for their long-term history and frequency of measurements. The metrics used on these plots combine techniques from multiple systems to give a broad range of complementary metrics that are useful in tracking trends in forest health over time.

Now the FEMC is working to expand this network across the region for more detailed, comprehensive annual field assessments of forest health across the region. In 2019 this included expansion to CFI plots in MA. In 2020 and 2021 we will work with state partners to design a robust plot network across all participating states in the seven-state region for annual forest health measurements to be completed by FEMC crews in partnership with states.

Project Work Plan

- Work with state partners to identify any plot locations, forest composition, and historical measurements to develop a unified sampling scheme to meet each state's forest health monitoring goals and the objectives of a region-wide assessment effort.
- Establish and conduct two years of measurements on 49 existing plots in VT (partially funded by other funding sources) and 152 new plots across participating states. If all states participate, we expect the following breakdown: Maine (35), Massachusetts (25), New Hampshire (30), New York (40), Connecticut (15) and Rhode Island (7). To ensure long-term viability and a focus on forest health, plot locations will preferably be limited to conserved or government-owned forestland not subject to active management, and coordinate with existing forest inventory and assessment plot networks. Crews will collect information on tree diameter, height, regeneration, invasive species presence, herbivory and multiple metrics of crown health, tree vigor, and canopy density.
- Conduct an initial baseline assessment and comparison of annual forest health metrics with USDA Forest Service Forest Inventory and Analysis data, and other forest health assessments (e.g. insect and disease surveys and satellite-based products) in a report to the Cooperative and a special session at the 2020 FEMC Annual Conference.
- Publish all data from the field season by December 2020 and December 2021 for each field season respectively.

STATE SPRINT PROJECTS

The state-directed projects are identified by state partners at Partnership Committee meetings during the period of the grant, and generally focus on identifying specific gaps in information, tools or analysis that FEMC resources are needed to fill. In addition, specific deliverables and time tables are outlined to ensure timely delivery of requested products. These vary by state each year, and in the past states have asked FEMC to overlay forest health metrics on forest inventory plots in Massachusetts, conduct a stream risk assessment for hemlock woolly adelgid in New York, and undertake a remote-sensing-based detection of forest clearing in New Hampshire. Vermont has chosen to maintain several ongoing, long-term monitoring efforts outlined under Summary of Remaining FEMC Core Program Activities in lieu of sprint projects.

FEMC will continue to provide sprint project support to states with participating governance structures, either through the advice of FEMC State Partnership Committees or an existing state committee or board serving in this capacity. FEMC will provide equal support through staff time to regional state partners according to their needs and priorities. This typically ranges from $7,000 to $13,000 per state per year.

SUMMARY OF REMAINING FEMC CORE PROGRAM ACTIVITIES

Strategic Planning and Implementation

FEMC staff will engage with a strategic planning committee in 2020 to develop a new Strategic Plan for the expanded regional Cooperative to replace the previous plan, in place since 2015 and updated in 2019. This will involve a review of all state forest action plans, and identification of key capacities to develop in FEMC to support activities complementing those forest action plans. This will result in the publication of a new FEMC Strategic Plan that updates the mission and documents key goals, objectives, activities and major deliverables for the organization through 2025.

Partner Engagement and Support

FEMC will aid communication among state, regional and national program managers and scientists to facilitate interdisciplinary cooperation in conducting studies around key forest health and ecosystem condition issues. FEMC staff will assist in securing additional funding to support ongoing long-term monitoring and related research, and will provide technical transfer to policy groups, natural resource managers and non-FEMC scientists.

In addition, FEMC staff will regularly travel to participating states to present the work of the Cooperative and engage new and current Cooperators. To support regional participation in governance of the program, FEMC will provide travel support for up to four members of FEMC committees traveling from outside Vermont to the FEMC Joint Committees meeting and the Annual Conference.

FEMC will facilitate networking and information sharing between scientists and natural resource managers through its committee work, data archiving partnerships with the Environmental Monitoring and Management Alliance and Catskill Science Collaborative in New York and the Holt Research Forest in Maine, continued involvement in the development of the Mt. Mansfield Science and Stewardship Center, and regional collaborations with adjacent states and others.

FEMC will organize and host an annual conference with forest ecosystem study results, workshops and material relevant to scientists, natural resource managers and educators. To encourage greater regional attendance, ten travel support awards will be given to poster and talk presenters from institutions outside Vermont. FEMC will pilot a "mini-conference" in Year 1 or 2 in a partnering state on a topic of regional significance and broaden the regional engagement with FEMC. In addition, FEMC will maintain a number of communication channels to facilitate outreach, including the development of stories for various newsletters and outlets, as well as maintaining a Facebook page, Instagram feed and Twitter account, and an active listserv.

Other Forest Health Monitoring and Information Sharing

Continued monitoring is needed to understand forested ecosystems and projects supported by this grant will include monitoring of tree phenology, forest pests and forest damages. Results are provided through a searchable website and database, publications, and the FEMC Annual Conference. Aerial survey detection data for 2019 will be archived and accessible through FEMC website and the [Northeastern Forest Health Atlas](#), and a summary of trends to date will be published in the FEMC long-term monitoring updates. FEMC will provide field support for the Urban Forest Inventory and Analysis program in Vermont, with direct costs funded by other sources.

Montane Meteorological and Air Quality Monitoring

FEMC collects meteorological data from montane areas to develop a long-term record of weather conditions and climatic changes over time. This includes two remote meteorological stations on Mt. Mansfield and a forest canopy tower at Underhill, Vermont. FEMC will continue to maintain an air quality monitoring site that houses a number of state and national efforts at Proctor Maple Research Center, including monitoring of acid precursors (CASTNET), ammonia (AMon), mercury (MDN), UVB radiation and wet acid deposition (VAPMP and NADP/NTN). This effort is largely funded by other sources. In addition, FEMC will maintain a CAMNET HazeCam in Burlington, Vermont.

Avian and Amphibian Monitoring

FEMC partners with two groups in Vermont to monitor and understand trends in forest avian and amphibian diversity and condition. Resources will partially support monitoring of diversity and population trends in amphibians, reptiles and forest songbirds at Mount Mansfield through subawards to Vermont Family Forests and Vermont Center for Ecostudies.

FPR Program Administration and Monitoring Support

FPR provides administrative and field work support in coordination with FEMC staff, including program coordination with partners by participating in Committee meetings, implementation of the FEMC Annual Conference, and expansion of FEMC through planning and participation on conference calls, surveys and meetings with FEMC partners in Vermont and in adjacent states. In addition, FPR staff provide training and methods standardization for State and UVM field crews involved in forest health monitoring field work and collect forest health and spring and fall phenology measurements. FPR staff also contribute to data processing, analysis and reporting for FEMC long-term monitoring updates.

Core Program Operations

Vermont will maintain infrastructure within the Division of Forests that allows for long-term monitoring and cooperative efforts with partners, maintain program infrastructure to continue to document

ecological monitoring data and study site oversight, and serve as the conduit for federal funding that will serve regional states through FEMC.

FEMC administration will be supported at UVM, including: a Principal Investigator, funded by other sources, who will provide programmatic and administrative oversight; a Director who will provide program planning, budgeting, outreach and daily operations; a Database and Web Developer who will maintain existing cyberinfrastructure and develop new functionality and tools; a Project Coordinator to facilitate implementation of FEMC projects; a Monitoring and Services Coordinator to oversee environmental monitoring projects and the FEMC fee-for-service work; and additional part-time staff as necessary.

FEMC staff will work with partners and cooperators to monitor trends and improve understanding of the role forested ecosystems play in providing important services such as clean air, clean water, aquatic biodiversity, carbon storage and mitigation of pollution impacts on soil chemistry. FEMC staff will continue to compile, store and link to monitoring data from partners in a centralized database that can be accessed via the internet, providing substantial regional information on biological diversity to support citizen education, land conservation, planning and natural resource management. FEMC will maintain and improve its core website infrastructure to meet this need and deliver online tools, dashboards and other information access products.

FEMC will maintain its core web-based archive and currently existing infrastructure, including: The DendroEcological Network, the Northeastern Forest Health Atlas, FragNet: The Northeast Forest Fragmentation Information Network, the FEMC Forest Health Monitoring database, the FEMC Long-Term Soils Monitoring database (Vermont), the Vermont State Lands Research Atlas, the Vermont Forest Indicators Dashboard and ecoNEWS VT.

In addition, FEMC will offer training and internship opportunities for students and new professionals.