Eastern White Pine Health and Responses to Environmental Changes

Business Meeting Minutes and Reports

USDA NIFA Multistate Group NE1601
2019 Annual Meeting
Hadley, MA

June 4-6, 2019

Attendees:

|  |  |
| --- | --- |
| Eric Norland | USDA NIFA |
| Brittany Barnes | University of Georgia |
| Aaron Bergdahl | Maine Forest Service |
| Mark Hutton | University of Maine |
| Bill Livingston | School of Forest Resources, University of Maine |
| Nick Brazee | UMass Cooperative Extension |
| Monique Sakalidis | Dept. Plant, Soil and Microbial Sciences, Michigan State University |
| Heidi Asbjornsen | Department of Natural Resources and the Environment, University of New Hampshire |
| Jeff Garnas | University of New Hampshire |
| Kyle Lombard | New Hampshire Division of Forests and Lands, Forest Health Section |
| Isabel Munck | USDA Forest Service Durham, NH |
| Kim Adams | SUNY-ESF Environmental and Forest Biology |
| Jessica Cancelliere | Bureau of Invasive Species & Ecosystem Health, New York State Department of Environmental Conservation |
| Robert Cole | New York State DEC |
| Mark Faulkenberry | Pennsylvania Bureau of Forestry |
| Sarah Johnson | Pennsylvania Bureau of Forestry |
| Tim Tomon | Pennsylvania Bureau of Forestry |
| Josh Halman  | Vermont Department of Forests, Parks & Recreation |
| Jill Rose | West Virginia Department of Agriculture Forest Health Protections Program Unit |
| Kristen Carrington | West Virginia Department of Agriculture Forest Health Protections Program Unit |

# BUSINESS MEETING NOTES

Bill Livingston welcomed the group to Hadley, MA. People in attendance who haven’t yet registered as a NE1601 member were encouraged to go to http://www.nimss.org. To join NE1601 (or any multistate), a prospective participant must submit an Appendix E in the National Information Management and Support System (NIMSS). Go to the Northeastern Regional Association of State Agricultural Experiment Station Directors (NERA) website for more specific guidance and read the pertinent section of the *Northeastern Supplement to the Guidelines for Multistate Research Activities* for instructions on how to file an Appendix E ([NERA Multistate Guide](https://4735ccc5-85de-42b4-96cb-0b13c7f9c210.filesusr.com/ugd/895599_141ac9bd78704e6e80d0b6527d323aba.pdf)).

The Mailing List of members and collaborators includes 91 names from 18 states, including Washington DC, and 2 provinces. People work at 13 universities, 6 USDA Forest Service offices, and 13 state agencies.

Minutes from 2018 were approved.

Election of officers:

Chair: Bill Livingston

Chair-elect: Kamal Gandhi

Secretary: Isabel Munck

2019 Report – please respond to request for accomplishments (papers, grants, etc.) after the meeting

Primary goal for 2019 is to submit a USDA AFRI Sustainable Agricultural Systems (SAS) proposal. Livingston explained the program’s priorities -expanding existing and creating new markets, increasing productivity, and curbing production losses due to environmental and biological stresses, including pests and diseases. The outcome will foster economic development and prosperity in rural America. Transdisciplinary teams that integrate research, education, and extension activities (= systems approach) are required. Each integrated activity should be represented by one or more objectives within the application. No more than two-thirds of a project’s budget being allocated to any single function.

The proposals are for five year projects with a total budget of $10 million. Requested funds need a dollar for dollar match with non-federal funds. See https://nifa.usda.gov/program/afri-sas.

A Letter of Intent is due June 4, 2019, and the University of Maine did submit one on behalf of the group. If the letter receives a positive review, full proposal due September 24, 2019.

A copy of the Letter is included in meeting attachments.

Eric Norland provided some consideration for the proposal. Information is provided in managing large scale transdisciplinary projects. There was a major project on loblolly pine, with Tim Barton as project manager. He should be contacted on how to manage a multistate project. Education aspects should be developed specifically for the project. The non-federal match should be included in the budget, and use of land can be part of the match.

After the business meeting , reports were given by Monique Sakalidis on Caliciopsis research, Brittany Barnes on Pine bast scale research and standardized sampling, Jeff Garnas and white pine needle damage, Isabel Munck and standardizing measurements for fungal problems on white pine, and Heidi Asbjornsen on Ecological physiology of eastern white pine. Copies and recordings are available from the NE 1601 web page at <https://forest.umaine.edu/news-resources/sfr-outreach/eastern-white-pine-health/>

After the presentations, attendees were divided into 2 groups.

Group 1: Research scientists and experimental forest managers. SAS objective to discuss:

Improve forest management to reduce losses in eastern white pine associated with insects, fungal pathogens, and drought.Chaired by Isabel Munck

Group 2: Forest health professionals and outreach specialists. SAS objective to discuss:

Transfer knowledge on eastern white pine best management practices to students, land managers, and the general public.
Chaired by Nick Brazee

Each group will provide a report on Friday morning.

**Plans for the coming year:**

1. Efforts will continue to submit proposals by individuals and multistate groups to support work on white pine health issues. Programs include the Sustainable Agricultural Systems for a range-wide proposal and the Sustainable Agroecosystems: Health, Functions, Processes and Management for a proposal from the Northeast.
2. There is interest in having the 2020 Annual Meeting at the Menominee Tribal Enterprises facility in Wisconsin. Bill Livingston will explore arrangements for the meeting.

# ADDITIONAL REPORTS

[**Future Research Notes for SAS proposal, from NE 1601 - Multi-state Meeting on Eastern White Pine Health 3**](#_Toc16751222)

[**Notes on Transfer Knowledge Strategies for SAS proposal, from NE 1601 - Multi-state Meeting on Eastern White Pine Health 4**](#_Toc16751223)

[**Monitoring eastern white pine (EWP) diseases 7**](#_Toc16751224)

[**Sampling for Eastern White Pine Bast Scale (Matsucoccus macrocicatrices) 10**](#_Toc16751225)

[**Letter of Intent to Submit an Application, AFRI Sustainable Agricultural Systems Program 11**](#_Toc16751226)

[**Field Manual for Managing Eastern White Pine Health in New England. University of Maine, 15**](#_Toc16751227)

# Future Research Notes for SAS proposal, from NE 1601 - Multi-state Meeting on Eastern White Pine Health

Chaired by Isabel Munck

Participants: Heidi Asbjornsen, Brittney Barnes, Jeff Garnas, Bill Livingston, Monique Sakalidis, & Isabel Munck

The purpose of the meeting was to determine research needs for eastern white pine forest health issues throughout the geographic range of white pine in stands under management regimes recommended by silviculturists. Our null hypothesis are:

1. Management does not affect insect pests and pathogen populations
2. Management does not affect tree health (resistance, condition)
3. Management does not change environmental conditions (temp, humidity, etc.)
4. Management does not affect economic value or timber quality

We are mostly concerned with Ho 1 and 2 since Ho 3 will be handled by economist, etc.

Ideally, we would like to study forests in New England, southern States and Lake States to cover the range of white pine (3 geographic locations). We are interested in 3 developmental stages (regeneration, pole size, mature stands). At each stand there would be a treatment and control. At each stand, there would be at least 5 plots. The total is 3 X 3 X 2=18 sites and 18 X 5=90 plots.

At all sites (or 90 plots?) we would monitor insect and disease incidence and severity, live crown ratio, and visual tree metrics before treatment. This would help us determine which of the 18 sites we would be most interested in. Site location may also be influenced by researcher residence. For the 18 sites, we would assess host condition 3 years after treatment (to be within the 5 year range of the proposal). Data loggers would be installed at each of the 8 sites to monitor environmental conditions before and after treatments. At the 18 sites spore traps and pheromone baited insect traps (?) would be set up to monitor insect and pathogen populations before and after treatment. Spores could be counted with aid of microscopes and also quantified with molecular methods once these have been developed. Intensive (3 times a year) and extensive sampling would take place at these 18 sites:

|  |  |
| --- | --- |
| **Intensive sampling** | **Extensive sampling** |
| sapflow | dendrochronology |
| Gas exchange | C13 |
| Spore and insect traps (?) | Signs/symptoms |
|  | carbohydrates |
|  | Dendro bands |
|  | Data loggers (temp, humidity, rain fall) |

Time of sampling would be coordinated among researchers and silvicultural treatments. For example, branches could be shot down for physiological measurements and scale counts. When silvicultural treatments take place, downed trees could be intensively sampled.

Ideally, there would be a technician at each of the 3 regions. Help for managers at each site would be required to change batteries, etc.

# Notes on Transfer Knowledge Strategies for SAS proposal, from NE 1601 - Multi-state Meeting on Eastern White Pine Health

Chaired by Nick Brazee

Participants: Jess Cancelliere, Rob Cole, Kim Adams, Alex Ashby, Nicholas Brazee, Kyle Lombard, Aaron Bergdahl, Timothy Tomon, Sarah Johnson, Jill Rose, Kristen Carrington, Mark Faulkenberry, Josh Halman

Definitions for column headings:

Lead: Who is responsible – Researchers, Project Admin, State Agencies, Extension, Forest, Other (name of person or group)

Separate budget: Prefer(need) to request budget agreement for funds

Pay per use: Money in Central Admin budget who will pay agency to complete activity as need arises (send invoice)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | Activity | Lead | Separate Budget | Per use |
| Publications with a broad audience | Action | Researchers, Extension?PA extensionCentral Admin |  | XX |
| Discussions with Certification organizations, FSC and SFI, TNC, AMC | Action | Project Admin |  |  |
| Barcoding or cataloging linked to a website with information on the project; need cell phone coverage? | Action | Contract to develop app;Need host server, Project admin |  |  |
| Signage (includes bar code, updating needed) | Action | Forest | XX |  |
| Field Days with landowners and foresters, multiple sites organized through existing groups. Make sure to offer credits | Action | State agencies |  | Xx |
| Virtual tour through various treatments | Action | You Tube videos, Univ. Marketing Groups? |  |  |
| Citizen scientist component to draw in general public | Action | ??? |  |  |
| Real time data stream |  | UNH- Heidi |  |  |
| Dedicated website for project? | Action | Proj Admin |  |  |
| Making presentations at various meetings | Action | State agency | xx | xx |
| Drawing in consulting foresters | Action | State agency | xx |  |
| State-based forest health meetings | Action | State agency | xx |  |
| Regular and updated summaries from researchers and their grad students -TRAVEL TO ANNUAL MEETING | Action | State agency | xx |  |
| Some kind of collective associated with white pine health | Action | Stearing committee |  |  |
| Clearinghouse or maintained website for summaries and material for dissemination, based out of a University (Bill); Forest Ecosystem Monitoring Cooperative – UVM (produce a dashboard) FEMC annual meeting | Action | Project admin |  |  |
| Web-based videos of the treatments, pests or pathogens | Action | Proj. Admi |  |  |
| Utilize existing social media accounts from University Extension in various states | Action | Proj. Admin contact and utilize existing state networks |  |  |
| State-by-state approach to most effective outreach methods (web-based to mailings) | Action | Proj. Admin contact and utilize existing state networks- extension, state agency |  |  |
| Plots have to be accessible with trails and parking | Goal |  |  |  |
| Financial justifications for the treatments over time | Goal |  |  |  |
| Control stands directly nearby | Goal |  |  |  |
| Clear example trees with pests and pathogens, soil pits; resin casting | Activity  | Jess NY; Jeff NH |  |  |
| Range of treatments clearly accessible and understandable | Goal |  |  |  |
| Treatments have to be successful  | Goal |  |  |  |
| Engagement with extension in other states to share research findings | Goal |  |  |  |
| Trying to draw in younger audiences,  | Activity | 4H programs |  |  |
| public opposed to any harvesting and | situation |  |  |  |
| Dealing with foresters with entrenched management views | Situation |  |  |  |
| Observation platforms | forest |  |  |  |
| State Agency Agreement |  |  |  |  |
| Plot work |  |  |  |  |
| Travel |  |  |  |  |
| Publication |  |  |  |  |
| Training sessionz |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

# Monitoring eastern white pine (EWP) diseases

Prepared by Isabel Munck

1. Record following data: diameter at breast height ( 1.3 m from the ground, dbh); crown position: Dominant, Co-dominant, Intermediate, Suppressed, or Dead; live crown ratio; crown density; White Pine Needle Disease (WPND) rating (0-3) and noting other significant information and recording observations.
2. Record whatever data is possible for dead trees.
3. Estimate overall crown density in 10% increments using the chart in Figure 1.
4. Estimate the live crown ratio in increments of 10% (Figure 2).



Figure 1: Crown density scale reference card[[1]](#footnote-1).



*Figure 2: Live crown ratio examples. Branches separated from the crown by a distance exceeding 5 feet should not be counted as part of the main crown.*

1. Estimate and record WPND symptoms in the crown: chlorosis, necrosis or defoliation: “0” = no symptoms, “1 = < 1/3 crown affected, “2” = 1/3 to 2/3 crown affected, “3” = >2/3 crown affected (Figure 3).



Figure 3: Reference for estimating proportion of crown symptoms.

1. Observe and record other agents of decline visible within the plot. For example, note the presence of Caliciopsis fruiting bodies on trees/saplings/seedlings, weevil damage of white pine bister rust.
2. If Caliciopsis is present on mature trees, record presence of Caliciopsis fruiting bodies, and severity of symptoms. Start at the top of the bole for each tree. Determine if Caliciopsis symptoms are old (O) or new=fresh (F). Fresh resinosis, white or clear, pitching indicates current infections. Older infected sites tend to be blackened, rough, sunken, and may still have pitch streaks visible. For fresh resinosis, note number of streaks up to 10 for each section of the bole (Top=T, M=Middle, B=Bottom), for two opposite sides/faces of the tree (T1 or T2). For older cankers/resisnosis, estimate symptom severity using these categories: “0”=no symptoms, “1”= 1-5% of stem with symptoms, “2”= 5-50% of the stem with symptoms, and “3”= >50% of the stem with symptoms.
3. Note presence or absence of Caliciopsis fruiting bodies from EWP seedlings (<1” DBH) or saplings (>1”-4” DBH). For seedlings, measure diameter at base. For saplings, measure DBH. Count the total number of branch whorls and also count the number of whorls that have Caliciopsis fruiting bodies.
4. Record if white pine weevil damage is present: branching in large, mature trees or dead terminal shoots in younger trees.
5. Record if white pine blister rust is present. White pine blister rust symptoms included aecial scars, flagging, spindle shaped cankers, bark discoloration, resinosis from a defined source, and crown discoloration.
6. Record presence of red rot caused by *Porodaedalea pini*. The fruiting body is brown and inconspicuous. Infected trees may exhibit resinosis at branch stubs.
7. Record presence of any other damaging agents such as Armillaria and Heterobasidion root rot, *Phaeolus schweinitzii*, beetle galleries or pitching: turpentine, bark, or ambrosia beetles, stem decay: white or brown rot, mechanical damage: lightning strike, wound, dead top.

**Sample Collection**

1. For foliar pathogens, collect samples in June through mid-July.
2. Identify trees/saplings with symptoms most representative of the entire stand. If it is not possible to collect foliage from overstory trees, please collect foliage from saplings.
3. Collect branch tips with symptomatic needles (include current growth and up to 3-year old needles if present) from several locations on the tree. Do not remove needles from fine twigs.
4. For Caliciopsis, collect bark with fruiting bodies (knife works well).
5. Place all samples collected from each tree in a separate one-quart sized plastic bag.
6. Keep samples dry inside the bag. Do not add water and if necessary, add a dry paper towel to absorb moisture.
7. Label sample bag with date, location, tree number, etc.
8. Keep samples cool (keep on ice during transportation from the field and refrigerate if they cannot be mailed right away).
9. If possible, please take pictures of the site and symptomatic trees, label them with date/plot number, store and send them address below in a thumb drive or share via google drive, etc.

# Sampling for Eastern White Pine Bast Scale (Matsucoccus macrocicatrices)

Prepared by Kamal J.K. Gandhi and Thomas Whitney, University of Georgia

**Sampling Protocol**

* The best time for sampling of the scale insect is during the winter*/*spring, especially January – March when the immature cyst stage is largest in size. March – April is fine if sampling in the North. The scale insect has a two-year cycle in the northern region and we don’t know if it’s synchronous emergence. This means that in first year, scales will be tiny, and the next year they’ll be big (~1.5 mm) and ready to become adults during this spring time-frame.
* Scales prefer thin, but mature bark. This translates to fewest insects present on new growth and thick bark with deep furrows. They also prefer branches in the lower canopy of all size classes. Thus, we’ll conduct sampling targeting these parts specifically.
* Sapling, poletimber, and sawtimber sampling: branch sections (5 trees each size-class; N=15/stand)
	+ Locate the lowest living whorl in the canopy.
	+ Cut two living branches from this whorl at random.
	+ Per branch, make cuts at the stem and one meter along its length.
	+ In total per tree, you should have two 1-meter branch sections cut proximally to the stem of the tree.
	+ In total per stand, you should have 30 one-meter long branch sections.
* Collected samples should be placed in the fridge until scale counts begin.
* The scale insect can be found under lichens, embedded within and around cankers, on the bark surface, and in the branch crotches (Figure 1). They are small, black, shiny, and look like little pearls. Empty shells of emerged cysts will be also be found which can be counted for an assessment of previous generation.
* Carefully look for and count the cyst stage in all these areas under a stereo microscope (or with a hand lens) – sometimes digging into the cankers, under lichen and in bark crevices with hard forceps (they can be deep down).
	+ Tally number of live cysts (current generation). Confirm they are alive by bursting the cyst with forceps to see if liquid hemolymph exudes out. Often you will encounter a voided cuticle or “shell,” the left-behind exoskeleton of an adult *M. macrocicatrices* (previous generations). Shells should be tallied separately.
* For a standardized density measure, convert the number of cysts into per unit area of the branch sample. With branch sections or bolts, we use the formula for the area of a truncated cone [A = *s*π (*r*1+*r*2) + π*r*12 + π*r*22]. “s” refers to the length and “r” refers to each radius of the branch section or bolt. This also means that all branch samples (1 m long) will be measured for total length and diameter on each side.

**References**

Schulz, A., Mech, A.M., Asaro, C., Coyle, D.R., Cram, M.M., Lucardi, R.D., and Gandhi, K.J.K. 2018. Association of *Caliciopsis pinea* Peck and *Matsucoccus macrocicatri*ces Richards with astern white pine (*Pinus strobus* L.) seedling dieback. *Forest Ecology and Management* 423: 70-83.

Whitney, T.D. 2019. Eastern white pine dieback: current colonization, biogeographic history, and genetic diversity of *Matsucoccus macrocicatrices* and its host. PhD Dissertation.

Whitney, T.D., Cram, M.M., Barnes, B.F., Yao, J., Lucardi, R.D., and Gandhi, K.J.K. 2018. Tree-level distribution of a novel insect-pathogen complex and its potential contribution to eastern white pine dieback. *Forest Ecology and Management*. *Forest Ecology and Management* 423: 49-58.



Figure 1. The 2nd instar cyst stage of *M. macrocicatrices*. (a, b) With their rigid, black, shiny cuticles, they resemble black pearls. They are extremely difficult to find in the field with the naked high, only reaching ~1.5 mm at their largest. They colonize hidden, tight spaces on *P. strobus*, such as within nodes (c), the edge of branch crotches (d), under lichen (e), and along the edge/within Caliciopsis cankers (f). The white arrow shows the *M. macrocicatrices* cyst and the gray arrow shows *C. pinea* ascocarps. Figure courtesy of Whitney (2019).

**Letter of Intent to Submit an Application, AFRI Sustainable Agricultural Systems Program**

Priority: (1) increasing profitability in agriculture through reducing input costs, increasing productivity, and reducing losses due to environmental and biological stresses, including pests and diseases.

**Project Director:** William H. Livingston, Assoc. Director and Assoc. Prof., School of For. Res., Univ. Maine. WilliamL@maine.edu

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**i. Title:** Eastern White Pine Alliance (EWPA): Enhancing Health, Productivity, & Resilience of a Widespread Yet Underutilized Forest Type

**ii. Rationale:** Increasing productivity, utilization, and sustainability of complex forest ecosystems will require a greater use of directed manipulations to reduce risks to tree health due to pests, disease, and changes in climate. Success in achieving healthier and more productive forests will depend on convincing key regional stakeholders that effective management interventions will improve forest sustainability and long-term value. The eastern white pine (EWP) forest type is ideally suited as a model for sustainable agricultural systems because i) it is prevalent through much of the eastern US; ii) it responds well to management that reduces health risks and defects; iii) it is a relatively high-value resource with potential to increase utilization; iv) reliance on natural regeneration, promotion of fast growth, and incentives for growing larger trees make the system more likely to gain social acceptance for management; and v) EWP will generally do well under climate change due to its adaptability.

**iii. Overall hypothesis or goal:** Effective management of the EWP forest type as a larger sustainable agricultural system will increase value and utilization as changes occur in the environment, and targeted outreach/education will increase social acceptance of these management practices.

**iv. Specific Objectives** (Long-term underlined, short-term follow)

1. Measure, evaluate, and project EWP productivity and sustainability over 25 years by establishing an innovative network of 6-9 research forests across the forest’s range, NC to ME to MN. Replicated, manipulative experiments of alternative management treatments will be established across the network and tracked through time with intensive monitoring.
2. Improve EWP forest management strategies to reduce losses associated with insects, fungal pathogens, and drought.This will be achieved by: i) quantifying current status of insect pests, fungal pathogens, and tree water and nutrient dynamics; ii) assessing similarities and differences in health problems using the regional network; and iii) conducting transdisciplinary research to assess forest health, climate, and management interactions.
3. Transfer knowledge on EWP best management practices to students, land managers, and surrounding communities. This will be achieved by: i) hosting hands-on field courses for university and high school students; ii) conducting multi-media technology-transfer programs that will prepare managers to implement best practices; and iii) developing a strategic multi-dimensional outreach program that will help surrounding communities understand and support management practices enhancing forest health and productivity.
4. Improve local rural economies by increasing EWP quality, value, and utilization. This will be achieved by i) assessing market suitability for white pine products across its range, and ii) providing specific recommendations for increasing utilization of EWP.

**v. Approach - Scope of systems**

EWP System: EWP is a major component of the eastern forest with over 186 million mbf (15 billion ft3) in 25 states. The resource can be underutilized as 10 states now have over 5 million mbf, but only 4 of them harvest more than 1.5% of the available resource. In Maine, EWP saw logs can sell for $190 to $300 mbf-1, but in another state logs sell for $20-$80 mbf-1 despite being abundant. The species responds extremely well to management as it can naturally regenerate after harvesting and continues rapid growth at even large sizes (>20 in. DBH) if densities are kept low. Managing stand densities can also ameliorate losses due to drought, fungal pathogens, and insect pests. Unmanaged stands can suffer mortality over 50%, but general social resistance to harvesting can hinder proper management, and investments are often not made.

A transdisciplinary, systems approach: A regional network of 6-9 permanent field sites will be established in EWP forests throughout its range and will support emerging research, outreach, and education. Efforts will integrate multi-scale studies across disciplines including EWP management, bird population dynamics, eco-physiology, fungal pathogens, insect pests, and human dimensions. EWP stands will be treated using alternative management strategies for naturally regenerating seedlings in mature forests (70+ years), for commercially thinning trees in medium forest (30-50 years), and for thinning dense stands of young forests (10-20 years). The practices will increase the quality, value, and resilience of the trees across the forest’s climate gradient. Measurements on permanent plots, 15 to 45 per forest, will include standardized procedures for assessing tree growth, quality, and product potential (i.e., log grades), health, and habitat. Assessments of sap flow, leaf gas exchange, water use efficiency, water pathways, soil moisture, and foliar/soil nutrient content will be collected across treatments and linked to climate data and management effectiveness. Fungal detections, pathogenicity tests, and population structure for cankers and EWP needle damage will be completed. Population levels of bast scale, blister rust and weevil will also be measured. Social reactions to the tree research and forest management will be assessed. Forest market specialists will characterize and value EWP markets throughout the region and assess opportunities for improving species utilization.

A full-time forest extension and education specialist will be hired to coordinate all research, education, and outreach activities. Integrated teams of researchers, state agency personnel, extension personnel, and forest managers will not only research EWP responses to management treatments but will also engage in outreach activities for other forest health professionals, foresters, and surrounding communities. The specialist will also organize week-long field camps for high school and college students to learn from researchers and forest managers at the research forests. The specialist will collaborate with The Future Farmers of America to connect with high school students. Contacts with Native American communities will also help to incorporate their priorities for sustainable EWP forests and engage their students. The total effort will allow the knowledge gained to spread among the broader professional and public communities where EWP occurs. The full-time specialist will work with social scientists to assess public response to the information and changes occurring at the study sites. UMaine’s Center for Research on Sustainable Forests will administer the project, supervise data management, and work directly with the external evaluator.

**vi. Potential impact and expected outcomes:**

The research network will establish the basis for evaluating long-term EWP sustainability and will allow future assessment of how system dynamics change over time. In addition, it will allow researchers, foresters, and the surrounding communities to assess which management strategies ensure sustainability. Improved productivity and public acceptance of forest management will improve utilization and economic revenue across the range of the EWP forest type. The EWP alliance (EWPA) effectively leverages an ongoing multi-state USDA initiative and will serve as a model system for sustainably managing other forest systems due EWP’s large geographic extent, high complexity, and strong mixture of interested stakeholders including private landowners, state agencies, Native Americans, non-industrial private landowners, and Federal agencies like the US Forest Service.

# Field Manual for Managing Eastern White Pine Health in New England. University of Maine,

Prepared by Livingston, W.H., I. Munck, K. Lombard, J. Weimer, A. Bergdahl, L.S. Kenefic, B. Schultz, and R.S. Seymour. Maine Agricultural and Forest Experiment Station, Orono, ME. Miscellaneous Publication 764. 20 p.
Available for download at: <https://digitalcommons.library.umaine.edu/aes_miscpubs/>

1. Crown density is the amount of crown branches, foliage, and reproductive structures that block light visibility through the projected crown outline. Although foliage transparency and crown density are similar measures, they cannot be interpreted as exact inverses. Crown density measures the amount of sunlight blocked by all biomass produced by the tree (both live and dead) in the crown, whereas foliage transparency measures the amount of sunlight penetrating only the live, foliated portion of the crown (Figure 2). When determining live crown ratio, if there are only 1 or 2 branches at the base of the crown, disregard the lower branches if they are separated from the main portion of the crown by more than 5 feet (Figure 3). Focus on the majority of the crown for both density and live crown ratio. [↑](#footnote-ref-1)