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NORTHERN HARDWOODS RESEARCH INSTITUTE'S QUARTERLY NEWSLETTER



HARVEST KNOWLEDGE | PROMOTE GROWTH



Institut de recherche sur les feuillus nordiques Inc. Northern Hardwoods Research Institute Inc.



Celebrating a decade of growth, innovation and leadership in the forestry sector

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Cover Photo: Sugar maples in full autumn colour, Oro-Medonte, ON (photo credit: Jennifer Saunders)

FOREWORD

WELCOME TO THE AUTUMN EDITION OF THE LEAFLET *Susan Willis*, Research and Development Forester | Northern Hardwoods Research Institute

Hello,

As we head into another season, with our beautiful hardwood forests showcasing their most magnificent colours, I want to welcome you to the Fall 2022 edition of The Leaflet.

Fall is always a busy time in the woods, ramping up for a productive harvest season (when not navigating the mud!) and there is no exception for NHRI.

In addition to ongoing field and office work for a variety of projects, NHRI has been participating in the Canadian Woodlands Forum Fall Meeting hosted by Acadian Timber in Edmundston. We took advantage of this meeting for celebrating our 10-year anniversary with friends and partners. This great event has been the opportunity to gather with so many supporters. As I fully transition into my new role at NHRI, I'm anxious to take advantage of this busy season to connect with my projects and partners, and really get started on this exciting journey.

I hope you enjoy this edition of the Leaflet and find the work of my colleagues informative and inspiring. Thank you for your continued support of NHRI!

Susan Willis Research and Development Forester







The creation of the Institute in Edmundston in 2012 was the result of several years of efforts when organizations, including the School of Forestry at the Université de Moncton, major forestry companies in New Brunswick and governments came together. The importance of hardwoods in our forests is undeniable but has not always been the priority in the management strategies of the past.

NHRI was created under the leadership of Université de Moncton after many years of preparation. The involvement and commitment of private sector was instrumental in securing five years of funding for the core operations of the Institute and ensure the research would address immediate needs. For the first five years, the Institute operated as a component of Université de Moncton and became the only applied research center in the field of forest management in Atlantic Canada. This year, we are happy to celebrate our ten-year anniversary at the Northern Hardwoods Research Institute. Our small, applied research centre has thrived and survived in this very competitive environment and has ensured that it is here for the long-term. Our anniversary was celebrated during the Canadian Woodlands Forum in Edmundston on October 4th.

PHASE I (2012-2017): The Start-up

The original partners of the Northern Hardwoods Research Institute were Université de Moncton, Groupe Savoie, AV Group, J.D. Irving Limited and Acadian Timber. The first five years, under Université de Moncton were spent at establishing the foundation and identifying the priorities for the sector. We hired new employees, developed the operations model, secured key research partnerships and additional funding and,

developed our mobilization approach. The funding came from the Atlantic Canada Opportunities Agency, the New Brunswick Regional Development Corporation, and private partners. Université de Moncton provided the venues, maintenance, and administrative support.

Research at NHRI was conducted to produce and mobilize the knowledge and tools required to optimally manage northern hardwoods and mixed forests, for overall yield, high proportions of high-grade products, timber value and long-term sustainability.

It became very clear early on that the focus of our Institute be on fixing the anticipated shortfalls in the wood supply.

The objectives became to:

- Increase the growing stock of northern hardwoods and the sustainable harvest levels
- Increase the quality of tolerant hardwoods so they produce more sawlogs
- Increase the proportion of sugar maple

The Institute is at the service of the entire forest sector and its mission is to produce and mobilize the knowledge and tools required by forest stakeholders to manage northern hardwoods and mixed forests optimally, reduce the gap in the growing stock, maintain high proportions of sugar maple and saw timber.

In the first five years, more than forty highly qualified people worked at the Institute and several graduate students obtained degrees from its support.

In the first five years, the Northern Hardwoods Research Institute interacted with over 1500 forestry and natural resource professionals and organized numerous training activities. It also began to explore how precision forestry tools such as drones, LiDAR and remote sensing could enable more rapid uptake of knowledge to improve forest management. The NHRI was well established, provided important tools and solutions for the sector and was ready for its growth stage.

In the spring of 2017, the Northern Hardwoods Research Institute was awarded the prestigious Premier's KIRA award for Innovation by private sector.

This award was earned for the development of the NHRI Silviculture Prescription System for the entire forest sector. The framework, methods, tools provided by the SPS are well suited for the adaptive management of our resources in the context of managing for tangible results and outcomes.

Our Silviculture Prescription System leverages our body of work in silviculture research as well as that of others and distills it down to detailed prescriptions on how to implement harvest-based silviculture to meet the objectives of the sector.

PHASE II: Independence and Growth

Unanimously, the partners concluded that to be more agile and efficient, a new governance and operating model needed to be implemented. In January of 2017, the Institute incorporated as an independent not-for-profit organization. Université de Moncton remained as a partner and continued to offer the venue to house the NHRI. The governance model includes a board of directors, a stakeholder committee and ad-hoc scientific panels as required.

We lost one industrial partner in the transition, but NHRI gained some important new ones. The New Brunswick Federation of Woodlot owners, representing more than 40,000 forest land owners is now a member. Forest NB, the organization representing most industrial stakeholders is also an official member.

For the new phase, the NHRI's objectives consisted of:

- Developing better knowledge of the hardwood resource in New Brunswick.
- Developing silviculture methods that encourage the sustainable yield of desired species and products.
- Creating methods and harvesting techniques that improve volume and value for the existing and future hardwood resource.
- Ensuring transfer of knowledge and results to the members of the forest sector.
- Influencing forest policy based on the results of NHRI research.

The focus of the second phase has been to continue improving its products and to mobilize knowledge more effectively. While the vocation of the Institute remains to produce solutions to manage mixed and hardwood stands more sustainably through applied research, much of the energy has been invested in developing highly competent forestry professionals who are able to work beside NHRI's partners in the field to implement solutions and bring back ideas for future development work. We have widened our clientele to include small private woodlot owners and those interested in growing hardwoods for other values.

It has become obvious that benefits in forest management will be realized only if digitalization rapidly increases in the sector. Despite substantial advancements made in individual components of the digital value chain such as LiDAR derived enhanced forest inventories and the use of on-board-computer data, there currently exist many substantial gaps in accuracy of predictions, data integrity, seamless process flow and maturity of the solutions available to users.

It has become obvious that benefits in forest management will be realized only if digitalization rapidly increases in the sector.

So that precision forestry tools can be enabled, the Northern Hardwoods Research Institute has launched a multi-year digital transformation project. It establishes the basis and introduces a framework for stakeholders in the New Brunswick forest products sector to engage into the digitalization of the value chain.

Named 'Digital Timberlands 20/20', the project focuses on the upstream part of the value chain. This project will leverage the benefits of Artificial Intelligence (AI) and cutting-edge technologies to enable

the digital transformation in the forest products value chain and provide the foundation for other processes further downstream.

Key deliverables from this initiative include methods, processes and algorithms to correct bias and errors in data, improved processes and algorithms to measure trees by harvesters and optimize bucking, methods to extract single-tree metrics from super high point clouds, better simulation of partial harvest treatments, tools and solutions to geo-position assortments of products in the cut block that can be linked to the harvester's data and, methods to make data flow seamlessly for analytics across the whole value chain. The project will also provide for many demonstrations of new emerging technology in the sector.

For ten years now, the NHRI has enabled the forest sector to implement new approaches to manage mixed and hardwood stands better in a way that secures the future of our supply and of our industry. NHRI has become a critical hub in the value chain, a networking facilitator and enabler of innovation. It has also created a novel precision forestry lab and has secured many formal collaborations with private sector firms, universities, and other research centres.

We have strengthened our network of collaborators such as: Université de Moncton, University of New Brunswick, Université de Sherbrooke, University of British Columbia, Université Laval, College d'Enseignment et de Recherche en Foresterie (CERFO) and the University of Maine's Collaborative Forest Research Unit (CFRU). Our partnership with the Atlantic Forestry Review is another example of strategic initiatives at NHRI to reach as many landowners as possible.

Through the years the NHRI has become the go-to organization in the management of mixed and hardwood stands as well as digitalization of the forest products value chain in eastern North America. We are very grateful to the founding partners of our Institute, our employees and collaborators and are looking forward to a prosperous future.

PHASE III: Relevance, Self Sufficiency, and Entrepreneurship

The next phase will see the Institute more and more involved in the production of next generation digital forest inventories, work closely with government agencies and private sector enabling decision makers, forest managers and silviculturists with the knowledge and the tools required for the sustainable management of our northern mixed and hardwood forests. We will establish the foundation so that we are less dependent on government subsidies and will strive to commercialize our intellectual property.

We are very excited that the New Brunswick Department of Natural Resources and Energy Development has formalized its partnership with NHRI. An announcement will be made soon on how the Institute will play a key role in

developing solutions for the most important challenges the sector is facing. Research centers talk about impact factor of their work all the time. But unlike others, we do not attempt just to publish in high-ranking scientific journals, for NHRI the ultimate impact factor is when decision makers and policy makers reach out to us to make improvements in forest practices.

Right: NHRI Staff and collaborators

Years

In his address at the 2022 Canadian Woodlands Forum fall meeting in Edmundston, Chris Ward, Assistant Deputy Minister of NB DNRED said it best: "The Northern Hardwoods Research Institute has established itself as the most credible forest management applied research center in Atlantic Canada and eastern North America. The solutions it develops are very useful, novel, and pertinent to solve our current challenges not only on Crown Lands, but also for freehold lands and private woodlots. When the NHRI delivers and mobilizes its knowledge to stakeholders, it elevates the image of forestry for the sector as a whole and not only for the forest management of and hardwood mixed stands."

"The Northern Hardwoods Research Institute has established itself as the most credible forest management applied research center in Atlantic Canada and eastern North America."

Since 2016, Bastien has been part of the NHRI team as a postgraduate student where he devotes himself, as part of his research, to mobile LiDAR and everything related to it. With this remote sensing technology, it allows us to see and understand the forest differently. To learn more about his work, we invite you to read the article below.

STUDY CONTEXT

Although forestry companies have access to products from various remote sensing technologies to support the strategic and tactical level of forest inventory (e.g. satellite imagery, aerial LiDAR or photogrammetric surveys), they lack precise information at the scale of individual trees to assess the accuracy of predictive models and support harvesting operations. In a context of forestry labor shortage, the integration of new tools capable of providing precise data on the dendrometric parameters of trees is one of the priorities established within the NHRI's <u>Digital Timberland 20/20 project</u>.

INVESTIGATION PHASE

NHRI has been testing different mobile LiDAR models for several years now to support forestry operations. A mobile LiDAR is a tool capable of quickly collecting high -resolution 3D data simply by moving through the forest. Most of the tests carried out so far had proved unsuccessful, mainly due to the limited range of the mobile LiDAR (maximum 15 m) and the lack of robustness of their processing algorithms (poor calibrations of the sensors which made the point clouds inaccurate in forest environment). These sensors were then deemed too immature for operational use (Figure 1).

Figure 1. Example of initial unsuccessful tests carried out a few years ago with older generations of mobile LiDAR. Above Left: illustration of the limited range of mobile sensors (MLS) compared to terrestrial LiDAR. (TLS). Right: duplicate effects observed in point clouds due to poor sensor calibration.

However, with recent technological advances in LiDAR sensors and their miniaturization, new generations of mobile LiDAR, such as the <u>ZEB Horizon</u> (© GeoSLAM) or the <u>Hovermap</u> (© Emesent) have emerged and are increasingly accessible. These sensors, more robust, better calibrated than their predecessors and equipped with an increased effective range of approximately 40 m, could well meet the needs of the industry. In this context, NHRI has established a collaboration with <u>RMUS Canada</u> to investigate the potential of the <u>Hovermap</u> mobile LiDAR for the rapid digitization of field plots in hardwood forests. A first phase of tests, carried out a year and a half ago in the Haliburton research forest in Ontario (the pandemic did not allow us to cross the maritime bubble at the time), proved to be much more promising (Figure 2).

EXPERIMENTAL PHASE

A collaboration was thus established with the geomatics department of the Université de Sherbrooke in the fall of 2021 for the establishment of a first experimental study site of 1 ha in a mature stand of sugar maple near Edmundston, NB. This site was completely digitized in 45 minutes using the Hovermap mobile LiDAR.

Nine inventory plots distributed within the experimental site were measured and scanned using terrestrial LiDAR to obtain very high-resolution 3D reference data. In addition, 26 sample trees from these 9 plots were felled and sawed by a multifunctional harvester operated by J.D. Irving Limited. The merchantable timber volume of these 26 trees was measured manually by the NHRI team and constitutes a second field reference measurement. The purpose of this device is to assess the accuracy of the mobile LiDAR for the extraction of height, diameter at breast height (DBH), crown dimensions and merchantable timber volume (Figure 3).

Figure 2. 3D acquisition collected from the ground with a Hovermap mobile lidar on an 80 m x 80 m plot (collection time: +- 30 minutes) Top image: 0-10 m high slice in the point cloud illustrating the position of the stems and the trajectory followed (in colour). Bottom image: slice of 120 m x 8 m in the point cloud carried out on the diagonal of the plot illustrating the range of the sensor (height of the dominant trees: 20-27 m). Mature hardwood stand - Haliburton Research Forest, Ontario.

Figure 3. Graphical summary of the study carried out on the potential of mobile LiDAR and available in open access in the Remote Sensing journal: <u>https://doi.org/10.3390/rs14184522</u>

KEY RESULTS OF THE STUDY

The results of this first study revealed that the mobile LiDAR had a strong potential to extract fine information on stem structure and dimensions, as well as tree branching (Figure 4).

Figure 4. Illustration of the 26 pairs of trees from 3D point clouds captured by terrestrial LiDAR TLS; top) and mobile LiDAR (MLS; bottom). Manual segmentation. Mature hardwood stand scanned off leaves – Saint-Quentin, New Brunswick

Here are some key results obtained with the mobile LiDAR on the 26 study trees:

- The merchantable volume of the trunk (main stem up to a small end diameter outside bark (DOB) of greater than 8 cm) was estimated with high precision compared to terrestrial lidar measurements (RMSE = 0.11 m³ (8.32%), BIAS = -0.03 m³ (-2.27%), R² = 0.96) and compared to the scrolling model of Li & Weiskittel calibrated for the Acadian region (RMSE = 0.16 m³ (14.7%), BIAS = 0.04 m³ (5.29 %), R² = 0.93).
- The operational merchantable volume (trunk and branches with a DOP ≥ 8 cm and a length ≥ 244 cm) was overestimated compared to the destructive measurements (RMSE = 0.42 m³ (21.82%), BIAS = 0, 28 m³ (14.55%), R² = 0.94). A detailed analysis showed that this overestimation comes from the branches and not from the main trunk.
- The height was estimated with <u>good accuracy</u> (RMSE = 0.42 m (1.78%), BIAS = 0.39 m (1.61%), R² = 0.93) compared to terrestrial lidar.
- The **diameter at breast height** was also estimated with <u>good accuracy</u> (RMSE = 1.21 cm (3.07%), BIAS = -0.95 cm (-2.41%) R² = 0.99) compared to terrestrial lidar.

Review and Prospects

Mobile lidar is a very promising tool for collecting 3D ground reference data. It is a sensor that is easy to transport in the field (weight around 2 kg) (Figure 5), quick to deploy and does not require extensive training to use (simple on-off button). Furthermore, the pre-processing of the raw data is relatively simple and automated.

Figure 5. Illustration of a mobile LiDAR data collection carried out within a 11,28 m circular plot in less than 5 minutes. The point cloud as well as the trajectory followed at ground level is illustrated on the right (automatic pre-processing of data to obtain the point cloud: 10 minutes).

Although the new generations of mobile LiDAR are compatible with operational forestry, their use in the forest environment is still in its infancy and more tests are needed to assess their potential in different types of forests. We note that even if the technology has evolved considerably over the past three years, there is still development to be done in terms of data processing. When it comes to extracting simple attributes such as diameter at breast height or tree height, there are already quite effective solutions. Estimating the volume of merchantable timber requires more complex algorithms that are not yet automated at the plot or stand scale. The most complex part is usually to automatically isolate the individual trees from the point cloud (Figure 6); aspect that can be complex in dense and/or multi-storied forests.

Figure 6. Example of automatic segmentation of individual trees from a 3D cloud collected with a mobile LiDAR.

In view of the promising results obtained during this first study, the NHRI continues to explore the potential of mobile LiDAR. Scans were carried out in several 1 ha sites to test the robustness of the technology and processing software. Collaborations have notably been initiated with researchers from the University of Liège (Gembloux Agro-Bio Tech) and a French postdoctoral researcher specializing in tree architecture to further the development of computer tools. If, like us, you see great potential in this technology and wish to collaborate, do not hesitate to contact us at the following address: <u>bastien.vandendaele@usherbrooke.ca</u>.

For more information, we invite you to consult the article which is available in open access in the Remote Sensing journal in the special edition "<u>Terrestrial Laser Scanning of Forest Structure</u>".

The main results of the study were also presented at the Colloquium <u>TRIDIFOR</u>. The <u>PowerPoint</u> <u>presentation</u> is available on their website.

WINDOW ON LITERATURE – CURRENT AND PAST PUBLICATIONS

PRE-COMMERCIAL AND COMMERCIAL THINNING

In the next few newsletters, we will list some current and old publications on pre-commercial and commercial thinning.

This list has been designed to present the most important references in this field of forestry, taking care to include articles from the Maritime provinces, Quebec, Ontario and some New England states. Some of these publications also contain long-term monitoring of results.

Each new edition of the Leaflet will feature a compilation of scientific publications collected by Michel Huot. Michel is a forestry researcher and retired forester engineer of the Ministère des Forêts, de la Faune et des Parcs du Québec. He continues to monitor the rapidly developing literature in new fields of research including carbon, silviculture adapting to climate change, invasive species and ecosystem management.

Happy reading!

WINDOW ON LITERATURE – CURRENT AND PAST PUBLICATIONS

PRE-COMMERCIAL AND COMMERCIAL THINNING

MARITIMES

Atlantic Forestry Centre. The growth, branchiness, and resprouting of sapling northern hardwoods after spacing. 1995. Lees, J.C. Natural Resources Canada, Canadian Forest Service, Maritimes Region, Fredericton, New Brunswick. Information Report M-X-193E. 15 p.

PDF Download

Crown release of young sugar maple. 1960. Drinkwater, M.H. Government of Canada, Department of Northern Affairs and National Resources, Forestry Branch, Maritimes Forestry Centre, Fredericton, New Brunswick. Forest Research Branch Technical Note 89. 18 p.

PDF Download

Atlantic Forestry Centre. Thinning tolerant hardwoods in Nova Scotia. 1984. Lees, J.C. Canadian Forestry Service, Maritimes Forest Research Centre, Fredericton, New Brunswick. Information Report M-X-152. 12 p. <u>PDF Download</u>

Stand dynamics and tree quality response to precommercial thinning in a northern hardwood forest of the Acadian forest region: 23 years of intermediate results. 2017. Swift, D.E., Knight, W., Béland, M., Boureima, I., Bouque, C.P.-A., and Meng, F.-R.Scandinavian Journal of Forest Research 32(1): 45–59. <u>PDF Download</u> from the Scandinavian Journal of Forest Research

Impact of partial harvesting on stand dynamics and tree grades for northern hardwood trees of the Acadian forest region. 2013. Swift, D.E.; Duchesne, I.; Ung, C.-H.; Wang, X.; Gagné, R. Information Report FI-X-009E. NRCan, CFS-CWFC, Fredericton, NB.

PDF Download

WINDOW ON LITERATURE – CURRENT AND PAST PUBLICATIONS

PRE-COMMERCIAL AND COMMERCIAL THINNING

Commercial thinning guide for hardwoods in Nova Scotia. Robertson, Ronald G. and Young, Robert W., Hardwood Thinning Manual, NS Dept of Natural Resources, 1991, Amherst, NS

Read more Field Guide Manual

Quebec

Laurentian Forestry Centre. Éclaircie précommerciale dans une jeune érablière à bouleau jaune : résultats après 10 ans. 1998. Zarnovican, R. Ressources naturelles Canada, Service canadien des forêts, Centre de recherches forestières des Laurentides, Sainte-Foy (Québec). Rapport d'information LAU-X-123F. 19 p.

PDF Download

Résultats de 15 ans de l'éclaircie précommerciale dans l'érablière à bouleau jaune à Duchesnay, Québec Direction de la recherche forestière, note de recherche no.113. M Huot, F Savard - 2001 mffp.gouv.qc.ca Read more

Forestry Chronicle. Effets de l'éclaircie précommerciale et de la fertilisation sur un gaulis de 10 ans à dominance de bouleau jaune. Lise Robitaille, Gilles Sheedy, and Yvon Richard <u>Read more</u>

Image below: Atlantic Forestry Centre. Thinning tolerant hardwoods in Nova Scotia. 1984

NHRI PUBLICATION

MOBILE LASER SCANNING FOR ESTIMATING TREE STRUCTURAL ATTRIBUTES IN A TEMPERATE HARDWOOD FOREST

By Bastien Vandendaele, Olivier Martin-Ducup, Richard A. Fournier, Gaetan Pelletier and Philippe Lejeune

The emergence of mobile laser scanning (MLS) systems that use simultaneous localization and mapping (SLAM) technology to map their environment opens up new opportunities for characterizing forest structure. The speed and accuracy of data acquisition makes them particularly adapted to operational inventories. MLS also shows great potential for estimating inventory attributes that are difficult to measure in the field, such as wood volume or crown dimensions. Hardwood species represent a significant challenge for wood volume estimation compared to softwoods because a substantial portion of the volume is included in the crown, making them more prone to allometric bias and more complex to model. This study assessed the potential of MLS data to estimate tree structural attributes in a temperate hardwood stand: height, crown dimensions, diameter at breast height, and merchantable wood volume. Merchantable wood volume estimates were evaluated to the third branching order using the quantitative structural modeling (QSM) approach. Destructive field measurements and terrestrial laser scanning (TLS) data of 26 hardwood trees were used as reference to quantify errors on wood volume and inventory attribute estimations from mobile laser scanning data. We expect our results would provide a better understanding of the potential of SLAM-based MLS systems to support in-situ forest inventory.

For more information, please refer to our recent publication in the journal Remote Sensing in the Special Issue <u>Terrestrial Laser Scanning of Forest Structure</u>.

NHRI AND CFRU ANNOUNCEMENT

The University of Maine's Cooperative Forest Research Unit (CFRU) <u>https://umaine.edu/cfru/</u> and the NHRI have been research collaborators for many years. A formal agreement was in place until the pandemic and the restrictions it imposed made the two organisations focus on other priorities in the short term. In April of this year, with operations getting back to normal, the memorandum of agreement was renewed.

The CFRU has been around since 1975 and was created out of a need to react to the last spruce budworm epidemic. Like the NHRI, the mission of CFRU is to conduct applied scientific research that contributes to the sustainable management of Maine's forests for desired products, services, and conditions. Furthermore, they also work in close partnership with Maine and New England Forest landowners and managers to solve key forestry problems through applied research.

Both CFRU and NHRI will benefit greatly from close cooperation on joint research and outreach projects of mutual interest to our researchers and member organizations and will establish a framework for mutual collaboration, information exchange, and resource leveraging that advances their common interests. Both organisations have invited each other to actively participate in each other's steering committees.

We are pleased to announce that effective early 2023, the CFRU will produce a regular column in NHR's quarterly newsletter. The Northern Hardwoods Research Institute's mailing list will be augmented with that of the CFRU. Both organizations are very enthusiastic about this initiative and the renewed collaboration.

NHRI VIDEO ROOM NHRI VIDEOS

NE	N!

10 YEARS

NHRI celebrates its 10 years of creation in 2022. Watch our new video created to mark this anniversary.

SCENE SHARP TECHNOLOGIES

Learn about Scene Sharp and their partnership with the Northern Hardwoods Research Institute.

DIGITAL TIMBERLANDS 20 /20

The Northern Hardwoods Research Institute has launched a multi-year initiative to develop solutions in the digital transformation of the forest products value chain for the forest sector in New Brunswick and beyond.

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SUSTAINING OUR HARDWOODS

Sustaining our Hardwoods delves into the important subject of sustainably managing the northern hardwoods of the Acadian Forest region.

OUR FORESTS AT RISK

This video documentary delves into the subject of climate change, its potential effects on our forests and what can, and should be done to adapt.

FIRST AND SECOND PLACE AWARD FOR BOTH OF OUR EMPLOYEES

Two of our employees Storm Robinson and Susan Willis attended the Canadian Institute of Forestry's 114th National Conference and AGM September 11 – 14th in Sault Ste Marie, Ontario. They both produced posters with results from their MScF theses, which related to the conference and poster symposium theme "The New Normal". The theme included growing forests under a changing climate, silviculture in the 21st century, and sustainable forest management planning. Storm and Susan won the first and second place awards for their efforts.

Storm brought home the first place award for her poster: To meet the needs of the global forest products

market while sustaining our forests, we must understand the impacts of climate anomalies on forest growth.

AUTUMN 2022

One such anomaly that is predicted to increase with climate change is frost events. Changes in the frequency, duration, and intensity of winter thaw-freeze cycles and late spring frosts have an increasing occurrence under a changing climate. A defining species of the Acadian Forest Region, red

spruce is at risk due to its high sensitivity to temperature fluctuations and small population size.

Amongst the various approaches utilized to evaluate cold hardiness in woody plants, the electrolyte leakage method is one of the most precise and objective options. Here we apply standardization and model comparison to the electrolyte leakage method to allow us to compare cold hardiness in mature trees that came from seven different seed sources (provenances) throughout the red spruce range. Using tree rings from the same provenance trials, we look at the past 50 years of growth for declines that may have occurred due to historic frost events. We expect warm-adapted provenances to be less frost hardy overall during fall and spring, and that their annual growth was more heavily impacted during extreme frost events. The methods and results from this project will help land managers to make informed decisions on climate adaptation strategies such as assisted migration.

NHRI NEWS FIRST AND SECOND PLACE AWARD FOR BOTH OF OUR EMPLOYEES

Susan Willis brought home the second place award for her poster: Climate change is projected to have profound impacts on the Acadian Forest ecosystem.

Large uncertainties (climate and future disturbances effects on stand composition, structure) make it difficult to determine the best course of action (management). Novel forest simulation models allow us to grow the forest under a changing climate and disturbance regimes, assess vulnerabilities, and test different management strategies. In this project, iLand (v1.1.1), a landscapescale process-based forest model that offers

a novel approach for assessing the feedback between individual trees and their environment (ecosystem processes, climate, and disturbance), was used for the first time in the Acadian Forest Region (AFR). We applied the model to the forest of Prince Edward Island National Park (PEINP), a highly degraded forest with increased vulnerability to climate change. PEINP is an ideal landscape for the initial regional application of this model because of high intensity inventory data available for set up and calibration. The Park is also representative of the heavily disturbed forest found throughout the AFR, providing a framework for future studies to be conducted in the region using iLand. We shared our results from forest simulations under multiple climate change scenarios with and without wind disturbance. Forest outcomes were quantified through various stand measures and discussed in relation to the management goals of the Park, and implications of climate change for the AFR. As the accessibility and capacity of process-based forest models improves, this project provides a case-study for forest managers looking to expand their toolbox.

NHRI NEWS CANADIAN WOODLAND FORUM

On October 4 and 5, the Canadian Forest Operations Forum was held in Edmundston. On Tuesday, October 4, forest sector stakeholders gathered at the Palais des Congrès to discuss and participate in the various conferences presented. Gaetan Pelletier, Executive Director at NHRI presented a conference on the theme: Introducing and Approach for the large-scale Adoption of Precision Digital Forest Inventories.

Several NHRI employees were present at this forum where the organizers took the opportunity to celebrate the 10th anniversary of the Institute. During the meal, the participants were able to watch a video of the 10 years of the NHRI.

On Wednesday, October 5, the Forum continued in the forest for the technical program where three of our employees participated.

RADIO CAPSULES 10 YEARS—10 CAPSULES—10 WEEKS

In 2022, NHRI celebrates 10 years of existence. Since its creation, the Northern Hardwood Research Institute has worked in the field to find and propose concrete solutions to the challenges facing the forestry sector. The NHRI allows all players and stakeholders in the sector to have access to the knowledge and results of their research and thus enable them to contribute to the sound management of our forests.

NHRI is the only applied research center in Atlantic Canada and is located in Edmundston, NB. To mark its 10th anniversary, the NRHI is inviting you to tune in to our local Edmundston radio station, Frontière FM (92.7), to learn more about the Institute. A new capsule will be featured every week, for 10 weeks and presented by various speakers from the Institute and the forest sector. If you missed an episode or you would like to listen to them again, here's your chance!

Follow us on Facebook. (Note that the capsules are in French only).

Here are the themes and speakers of the audio clips.

	Capsule # 1	The creation of the Institute presented by Michel Soucy, member of the NHRI board of directors and professor at the UMCE forestry school.
	Capsule # 2	Hardwood issues in New Brunswick, presented by Alain Bossé, President and Chief Operating Officer of Groupe Savoie de Saint-Quentin.
	Capsule # 3	Sugar maple and its resistance to change presented by Carine Annecou, professsional forester and consultant at NHRI.
() I	Capsule # 4	The precision digital forest inventory presented by Eric Caron, president of Four Best Management.
	Caspule # 5	An initiative launched by NHRI to develop solutions in the digital trans- formation of the forest products value chain presented by Pamela Hurley Poitras, silviculturist and drone pilot.

RADIO CAPSULES 10 YEARS—10 CAPSULES—10 WEEKS

Capsule # 6	The system of silvicultural prescriptions created by the NHRI presented by Gaetan Pelletier, Executive Director at NHRI.
Capsule # 7	Forest management in the private sector presented by Diane Landry, Manager of the Madawaska Forest Products Sales Board.
Capsule # 8	The impact of climate change on our hardwoods presented by Adrian Prado, land analyst in research and sustainable development at the North-West Regional Service Commission.
Capsule # 9	The NHRI team presented by Roxanne Michaud, forestry technician at NHRI.
Capsule # 10	The future of NHRI presented by Gaetan Pelletier, Executive Director at NHRI.

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UPCOMING EVENT

NHC 2023 NORTHERN HARDWOOD CONFERENCE Bridging Science and Management for the Future

August 1-3, 2023

Northern hardwood forests occupy millions of hectares in the eastern United States and Canada, representing one of the most economically important and ecologically diverse forests in eastern North America. Northern hardwood silviculture is diverse and complex as well and has been the focus of extensive research for over 80 years. Today, managers continue to seek innovative sustainable management solutions to address the expanding challenges facing this forest type, including serious threats such as invasive species, inadequate tree regeneration and shifts in composition, degraded timber quality, herbivory, climate change, nitrogen deposition, and forest fragmentation. The 2023 Northern Hardwood Conference (NHC) will give researchers, academia, and forest managers from across the range of northern hardwoods a forum to learn, share, and discuss cutting edge science and innovative management practices to sustain healthy and productive northern hardwood forests.

The conference will be developed under the framework of "leveraging technology to improve silviculture and the digitalization of the value chain"; an innovative Canadian initiative in which New Brunswick will be the pilot and NHRI will be involved in a leadership role. This conference will illustrate key steps to the restoration and sustainability of hardwood and mixed-wood forests in the northeast of North America.

The showcase forest site will be used as a state-of-the-art educational and training tool to demonstrate adaptive silviculture techniques focused on problem solving and finding solutions at the operational level. The demonstration forest is also a site for training foresters and technicians from UNB, l'Université de Moncton, the Maritime College of Forest Technology, and the University of Maine.

The event partners include the Province of New Brunswick, AV Group, University of New Brunswick, l'Université de Moncton and the Canadian Forest Service, as well as private landowners and forest managers.

Registration information will be posted to our website in the coming months.

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