

Final Abstract

Final Report Approved on February 28, 2025

M.L. 2021 Project Abstract

For the Period Ending June 30, 2025

Project Title: Forest Health: Statewide Application of Forest Management Assessment Tool

Project Manager: Will Bartsch

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Funding Source:

Fiscal Year:

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 19

Appropriation Amount: \$500,000

Amount Spent: \$499,232

Amount Remaining: \$768

Sound bite of Project Outcomes and Results

The interactive ForCAST tool provides natural resource managers, decision makers, and the general public with information about how Minnesota's forested landscapes and the goods and services they provide may change under different future harvest and climate scenarios, supporting a more informed decision making process and broadening understanding.

Overall Project Outcome and Results

ForCAST is designed to provide projections of how forest composition and the goods and services that forests provide will change from 2030 to 2100 under different management and climate scenarios. Landscape change modeling was done using the LANDIS-II model with subsequent wildlife habitat and water quality and quantity modeling done using the Wildlife Habitat Indicator for Native Genera and Species (WHINGS) and Hydrologic Simulation Program - Fortran (HSPF) models. All models were run for each of the 12 unique combinations, four management and three climate scenarios, that generated the outputs for selection in the ForCAST Tool.

Minnesota's forests are still relatively young. The cutover and subsequent harvest of early successional species have

maintained a disproportionate number of acres in these forest cover types. Changing markets and a changing climate are affecting these species and acres as market demand declines, and modeled data shows increased difficulty in regeneration of early successional species. These species showed the highest loss of acres in the modeled outputs.

The drought tolerant mid and late successional species are holding up the best across all model paradigms. These species are moving towards a more normal age class distribution and many will reach a relatively normal age class distribution by 2100.

Model outputs on lowland conifers and hardwood will also be moving towards a more balanced age class distribution with declines of 2 to 5 percent of total acres. However, the model did not include insect and disease subroutines to model mortality due to emerald ash borer, spruce budworm and other significant threats. The outputs for these cover types must be understood in this context and the likelihood that losses of acres through mortality and conversion will likely be much higher than the modeled output suggests.

Project Results Use and Dissemination

The ForCAST tool is being promoted through a combination of presentations, professional engagement, and outreach. A presentation was given at the UMN Sustainable Forestry Education Cooperative's 2025 Forestry and Wildlife Research Review in January. It will be featured in the March or April issue of NRRRI Now. A webinar will be given through the Sustainable Forestry Education Cooperative in May, and additional meetings or presentations are currently being scheduled with the DNR, Minnesota County Land Commissioners, and the Minnesota Forest Resources Council. Google Analytics indicates 102 unique users of ForCAST during the first 45 days after launch.



Environment and Natural Resources Trust Fund

M.L. 2021 Approved Final Report

General Information

Date: March 13, 2025

ID Number: 2021-467

Staff Lead: Mike Campana

Project Title: Forest Health: Statewide Application of Forest Management Assessment Tool

Project Budget: \$500,000

Project Manager Information

Name: Will Bartsch

Organization: U of MN - Duluth - NRRI

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Project Reporting

Final Report Approved: February 28, 2025

Reporting Status: Project Completed

Date of Last Action: February 28, 2025

Project Completion: December 31, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 19

Appropriation Language: (a) The following amounts, totaling \$840,000, are transferred to the Board of Regents of the University of Minnesota for academic and applied research through the MnDRIVE program at the Natural Resources Research Institute to develop and demonstrate technologies that enhance the long-term health and management of Minnesota's forest resources, extend the viability of incumbent forest-based industries, and accelerate emerging industry opportunities. Of this amount, \$500,000 is for extending the demonstrated forest management assessment tool to statewide application:

(1) the unencumbered amount, estimated to be \$250,000, in Laws 2017, chapter 96, section 2, subdivision 7, paragraph (e), Geotargeted Distributed Clean Energy Initiative;

(2) the unencumbered amount, estimated to be \$20,000, in Laws 2017, chapter 96, section 2, subdivision 8, paragraph (g), Minnesota Bee and Beneficial Species Habitat Restoration;

(3) the unencumbered amount, estimated to be \$350,000, in Laws 2018, chapter 214, article 4, section 2, subdivision 9, paragraph (e), Swedish Immigrant Regional Trail Segment within Interstate State Park; and

(4) the unencumbered amount, estimated to be \$220,000, in Laws 2019, First Special Session chapter 4, article 2, section 2, subdivision 5, paragraph (a), Expanding Camp Sunrise Environmental Program.

(b) The amounts transferred under this subdivision are available until June 30, 2023.

M.L. 2022, Chp. 94, Sec. 2, Subd. 19 Carryforward; Extensions, (b) The availability of the transfers for the following projects is extended to June 30, 2024: (8) Laws of 2021 First Special Session, chapter 6, article 6, section 2, subdivision 19, paragraph (a), clauses (1) through (4), Forest Health Research, Development and Demonstration

Appropriation End Date: June 30, 2024

Narrative

Project Summary: This project is an expansion of the work began under LCCMR 2019 Forest and Bioeconomy Research. NRRI is requesting continuing Legislative support for two strategic applied research and demonstration projects.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Minnesota's forest products industries, sawtimber, paper, pulp and engineered wood products, contributed \$9.8 billion in forest product shipments and \$3.4 billion in direct value to Minnesota's economy in 2019 (Bergstrand 2019). Declining demand for forest products, a changing climate and new opportunities like carbon markets will require forest managers to think differently about how they manage forest lands and forest products industry about the potential products they can produce.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

To assist forest managers we will continue development of a forest management assessment and decision support tool and extend it from the 4 million acres (300K parcels) to cover the more than 17.4 million acres (1.6M parcels) of forestland in the state. This project will develop a spatially-explicit decision tool that integrates forest productivity, ecosystem service, and economic information to help land managers evaluate management options and select management practices that will meet their needs. To assist forest products industry we will continue to develop carbon-negative technology, that can be produced from biomass waste residues, customized for beneficial uses and can create new forestry and manufacturing jobs.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

This project will provide federal, state and county agencies, corporations, habitat management organizations and individuals with a tools that will help them to better understand the forest resources of the state, how changing markets, new technologies, new products streams and a changing climate will impact these forest lands and direct invest to better manage these lands sustainably.

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project

Activities and Milestones

Activity 1: Development of Stand level data and landscape level modeling

Activity Budget: \$370,000

Activity Description:

We will develop stand level summary statistics for utilizing available and model current stand conditions for public and private lands across the forest landscape of the state of Minnesota. We will convert this data into a format that can be used by an internationally accepted landscape level change model to model forest change across time. The landscape level change model will evaluate 4 harvest scenarios across the climate change scenario. These output will then be used to model ecosystem goods and services that will be provided under each of the scenario combinations through time.

Activity Milestones:

Description	Approximate Completion Date
Develop stand level data for all forest lands in the state of Minnesota	March 31, 2022
Convert spatially explicit stand level data to model input	June 30, 2022
Model landscape level change through time	September 30, 2022
Model ecosystem goods and services	December 31, 2022

Activity 2: Development of Map Application and Outreach Program

Activity Budget: \$100,000

Activity Description:

We will integrate forest management modeling and ecosystem service valuations into an online map-based application that will allow forest land managers and other stakeholders to weigh the costs and benefits of alternative management decisions based on current and future resource availability, supply chain issues, maintenance of ecosystem services, and predicted climate conditions. The application will be built using open-source software, providing us flexibility during the development process. To ensure that the application meets the information needs of the forest industry and is intuitive and stable, we will assemble a group of end users that we will regularly engage throughout development and testing.

Concurrent with the final stages of application development and testing, we will develop an outreach and training program. The program, which will be targeted at forest land managers and decision makers, will consist of in-person and remote training sessions, video tutorials, and a presence at relevant industry events.

Activity Milestones:

Description	Approximate Completion Date
Develop the map application with collaborator input; beta-test with end users	February 28, 2023
Launch the map application publicly	April 30, 2023
Conduct outreach and training sessions in model use, present and publish results	June 30, 2023

Activity 3: Voice of customer collection and client engagement

Activity Budget: \$30,000

Activity Description:

We will assemble an extensive and diverse group of stakeholder to collect information about their values, goal and management practices and develop management scenarios based on current and anticipated forest product needs. As

we move through the development process we will rely on their assistance to tell us what is working and what does not work, where the analysis is sufficient and where the data output is lacking and provide suggestions on what we can do to make the tool as useful as possible to planners and practitioners in the field.

Activity Milestones:

Description	Approximate Completion Date
Engage stakeholders to identify generally accepted management practices and scenarios	March 31, 2022
Analyze data and provide the modeling teams with recommendations for outputs	September 30, 2022
Review data analysis and suggest improvements to outputs	December 31, 2022

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Eli Sagor	University of Minnesota Extension	Dr. Sagor is the Program Manager for the U of MN Extension's Sustainable Forestry Education Cooperative. Dr. Sagor will provide support for the development and implementation of outreach and education activities for professionals and the general public.	Yes
Mae Davenport	University of Minnesota	Dr. Davenport is the Director of the U of MN's Center for Changing Landscapes. Dr. Davenport will provide support and assistance in the design and implementation of the voice of customer research to understand potential end-users needs.	Yes
Steve Polasky	University of Minnesota	Dr. Polasky is the Regents Professor of Evolution and Behavior in the Department of Applied Economics. Dr. Polasky will provide support and assistance in the quantification of ecosystems services.	Yes
Sarah Roth	University of Minnesota	Sarah Roth is a Researcher with the U of MN's Center for Changing Landscapes. Roth will assist with the development and implementation of the voice of customer process.	Yes
William R Herb	University of Minnesota	William Herb is a Researcher with the U of MN's Saint Anthony Falls Laboratory. Herb will lead the modeling efforts to quantify changes in water quality and quantity within the tool.	Yes
Brian Sturtevant	USDA Forest Service	Dr. Sturtevant is a Research Ecologist and Unit Leader for the Institute for Applied Ecosystem Studies. Dr. Sturtevant will be oversee the work done by his unit and will be responsible for the completion of the contract work as agreed.	No
Gordon Reese	USDA Forest Service	Research Ecologist with the Institute for Applied Ecosystem. Dr. Reese will be responsible for the for providing guidance, computer code, and other tools as necessary, based on experience and knowledge from previous projects, for selecting, acquiring, processing, and parameterizing input data and extensions for the LANDIS-II forest landscape model.	Yes
Kathleen Quinlan	USDA Forest Service	Dr. Quinlan is a Research Ecologist with the Institute for Applied Ecosystem Studies. Dr. Quinlan will provide support for the parameterizing input data and extensions for the LANDIS-II forest landscape model.	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

Deployment will include a beta testing phase that will gather feedback and recommendations for improvements to the tool. When completed, this tool will be deployed to end-users (industry, agencies, other stakeholders) with training supported and implemented by U of MN Extension through multiple outlets including the Sustainable Forest Education Cooperative. All public-facing research dissemination for this project will acknowledge the ENRTF funding for the project.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

This project will have an extensive advisory committee representing federal, state and county agencies, habitat conservation organizations, forest products industry and entrepreneurs to provide advice on the content and outputs. This same group will help to evaluate project outputs, drive engagement and help to socialize the tools.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount	\$ Amount Spent	\$ Amount Remaining
Personnel										
John Du Plissis		Du Plissis will serve as the primary investigator providing leadership and direction to the team. Du Plissis will also be responsible for overseeing the subaward with the USFS and insuring all contract obligations are met			25.09%	0.42		\$48,661	-	-
Will Bartsch		Bartsch will serve as the project manager as well as lead the graphic user interface team.			25.09%	0.38		\$35,010	-	-
Saleh Mamun		Mamun is a resource economist and will be responsible for the evaluation and modeling of ecosystem services.			17.28%	0.18		\$13,923	-	-
Lucinda Johnson		Johnson will provide advice and support to the water modeling team in the development of data and the selection and implementation of models.			25.09%	0.02		\$4,557	-	-
Alexis Grinde		Grinde will be responsible for data development, analysis and evaluation of the bird habitat within the wildlife management team.			25.09%	0.08		\$9,912	-	-
Michael Joyce		Joyce will be responsible for data development, analysis and evaluation of the small mammal habitat within the wildlife management team.			25.09%	0.08		\$6,977	-	-
Ron Moen		Moen will provide overall supervision and leadership to the wildlife habitat modeling team as well as be responsible for data development, analysis and evaluation of the large mammal habitat within the wildlife management team.			25.09%	0.36		\$55,843	-	-
Meijun Cai		Cai will be responsible for data development, analysis and evaluation of the water quality and quantity within the water modeling team.			25.09%	0.18		\$16,214	-	-

Christopher Wright		Wright will support the development of stand level summary data, the conversion of the data for use in the selected landscape change model and the modeling landscape change through time.			25.09%	0.52		\$55,088	-	-
Matthew Mlinar		Mlinar will provide project management support and serve as a part of the project management team for this grant.			25.09%	0.08		\$11,257	-	-
Jane Reed		Reed will lead the development of the interactive portion of the graphic user interface.			22.3%	0.18		\$12,294	-	-
Kristina Nixon		Nixon will provide support to the modeling and graphic user interface teams in the development of spatial data and how it is displayed in the graphic user interface.			22.3%	0.34		\$26,776	-	-
Kristofer Johnson		Johnson will lead the development of the graphic user interface, the integration of the landscape level change data into a spatially explicit geographic information framework and the integration of the model outputs into that framework.			25.09%	0.42		\$36,901	-	-
Steve Polasky		Dr. Polasky is the Regents Professor of Evolution and Behavior in the Department of Applied Economics. Dr. Polasky will provide support and assistance in the quantification of ecosystems services.			25.09%	0.02		\$9,018	-	-
Eli Sagor		Dr. Sagor is the Program Manager for the U of MN Extension's Sustainable Forestry Education Cooperative. Dr. Sagor will provide support for the development and implementation of outreach and education activities for professionals and the general public.			25.09%	0.08		\$9,661	-	-
Mae Davenport		Dr. Davenport is the Director of the U of MN's Center for Changing Landscapes. Dr. Davenport will provide support and assistance in the			25.09%	0.14		\$18,730	-	-

		design and implementation of the voice of customer research to understand potential end-users needs.								
Sarah Roth		Sarah Roth is a Researcher with the U of MN's Center for Changing Landscapes. Roth will assist with the development and implementation of the voice of customer process.			22.3%	0.2		\$14,807	-	-
William Herb		William Herb is a Researcher with the U of MN's Saint Anthony Falls Laboratory. Herb will lead the modeling efforts to quantify changes in water quality and quantity within the tool.			25.09%	0.24		\$25,235	-	-
TBD Researcher 4		This position will provide support to the wildlife habitat modeling team.			22.3%	0.18		\$12,022	-	-
TBD Technician, bargaining unit		This position will provide support to the modeling teams with administrative support as needed.			22.3%	0.02		\$1,305	-	-
TBD Technician, temp/casual		This position will provide support in the modeling teams to assist with the collection modeling and assessment of data.			6.91%	0.02		\$680	-	-
TBD Undergraduate Student		This position will provide support in the modeling teams to assist with the collection modeling and assessment of data.			0%	0.02		\$546	-	-
TBD Summer Graduate Student		This position will provide support in the modeling teams to assist with the collection modeling and assessment of data.			18.96%	0.02		\$211	-	-
							Sub Total	\$425,628	\$425,628	-
Contracts and Services										
USDA Forest Service, Northern Research Station (USFS)	Subaward	The USFS NRS Institute for Applied Ecosystem Studies will be responsible for providing guidance, computer code, and other tools as necessary, based on experience and knowledge from previous projects, for selecting,				0.5		\$68,922	\$68,154	\$768

		acquiring, processing, and parameterizing input data and extensions for the LANDIS-II forest landscape model								
							Sub Total	\$68,922	\$68,154	\$768
Equipment, Tools, and Supplies										
							Sub Total	-	-	-
Capital Expenditures										
							Sub Total	-	-	-
Acquisitions and Stewardship										
							Sub Total	-	-	-
Travel In Minnesota										
							Sub Total	-	-	-
Travel Outside Minnesota										
							Sub Total	-	-	-
Printing and Publication										
							Sub Total	-	-	-
Other Expenses										
		Domain & Hosting	The main deliverable is a web mapping application that requires both domain registration fees and web site hosting					\$700	\$700	-
		GIS Lab Fees	This project relies on the computing resources and data storage infrastructure					\$4,750	\$4,750	-

			of NRRRI's GIS Lab. This lab is supported through the application of fees to projects that use the labs resources.							
							Sub Total	\$5,450	\$5,450	-
							Grand Total	\$500,000	\$499,232	\$768

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	\$ Amount	\$ Amount Spent	\$ Amount Remaining
State						
			State Sub Total	-	-	-
Non-State						
In-Kind	Internal University (NRRI) funding	To support any project activities that occur after 6/30/2024	Secured	\$37,000	-	\$37,000
			Non State Sub Total	\$37,000	-	\$37,000
			Funds Total	\$37,000	-	\$37,000

Attachments

Required Attachments

Visual Component

File: [d2ecb444-613.pdf](#)

Alternate Text for Visual Component

The graphic describes the goal, opportunities benefits of the forest management opportunities and decision support tools as well as the inputs and out puts produced by the tool...

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Background Check	4891efe8-a84.pdf
Institutional Letter of Support	93ef1666-8ec.pdf
Priorities for Minnesota Forest Stewardship: A Survey of Forest Professionals	72e0a7c7-12a.pdf

Media Links

Title	Link
ForCAST Forest Change Assessment Simulation Tool	https://mnforecast.org/
2025 Forestry and Wildlife Research and Practice Review Presentation	https://www.youtube.com/watch?v=CEJJ-p5i_Kw

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

There were only minor changes made.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

N/A

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	<ul style="list-style-type: none"> • Budget • Budget - Personnel • Budget - Other 	Domain & Hosting was mistakenly omitted from the original budget. The main deliverable is a web mapping application that requires both domain registration fees and web site hosting. GIS Lab Fees was mistakenly omitted from the original budget. This project relies on the computing resources and data storage infrastructure of NRRI's GIS Lab. This lab is supported through the application of fees to projects that use the labs resources.	June 1, 2022	Yes	June 2, 2022
2	Completion Date	<p>Previous Completion Date: 06/30/2023 New Completion Date: 06/30/2024</p>	The initial plan of work called for a NRRI employee to identify, develop, and test model inputs and develop model input parameters for the landscape change model that is the core of this project. Due to complicating factors, it was necessary to develop a contract with the US Forest Service to accomplish this work. This led to an initial delay that has created the need to extend the timeline for completion of this project.	June 14, 2023	Yes	June 14, 2023
3	Amendment Request	<ul style="list-style-type: none"> • Budget - Non-ENRTF Funds Contributed 	Unexpected modeling problems have delayed the project and our ability to complete it and the final report by 6/30/24. All ENRTF funds need to be spent by 6/30/24. These funds will cover any project expenses incurred after 6/30/24.	June 5, 2024	Yes	June 14, 2024
4	Completion Date	<p>Previous Completion Date: 06/30/2024 New Completion Date: 12/31/2024</p>	We encountered unexpected problems with the foundational forest composition modeling, which set the entire project behind schedule. We have resolved those modeling issues and all components of the project are moving forward, but we are no	May 24, 2024	Yes	June 14, 2024

			longer able to finish the project and final reporting by 6/31/24. NRRRI will provide all funding beyond 6/31/24 that is required to complete this project.			
5	Amendment Request	<ul style="list-style-type: none"> • Budget • Other • Budget - Travel and Conferences • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Other 	We are requesting an amendment to increase personnel time and GIS Lab expenses because additional effort was needed for LANDIS modeling and our remote server and hosting expenses increased substantially since the initial budget was developed. We are requesting a decrease in travel because remote meetings were possible. Our USDA was decreased by \$88 because they did not require the full amount originally budgeted to them.	August 29, 2024	Yes	October 16, 2024

Status Update Reporting

Final Status Update February 14, 2025

Date Submitted: February 13, 2025

Date Approved: February 18, 2025

Overall Update

The goal of this project was to provide government agencies, corporations, habitat management organizations, and individuals with a tool that will help them to better understand the forest resources of the state and how they might change in the future under changing markets, new technologies, new products streams, and a changing climate. This information will provide land managers with information that helps them to directly invest in sustainable land management. The ForCAST tool is now complete and is publicly accessible on the internet at mnforcast.org. The tool allows individuals to evaluate an area of interest under multiple future scenarios. They can select one of four management scenarios that were designed to reflect changes in the economics of Minnesota's forest industry and consequent demand for pulp and lumber. They include no change, 30% increase in harvest, 30% decrease in harvest, and maximization of carbon sequestration on the landscape. Additionally, they can select one of three climate scenarios. The first is based on recent historical data, the second is hotter and slightly wetter, and the third is hotter and wetter. Users can evaluate projections of forest metrics, habitat quality, water quality and quantity, and economic valuation under those scenarios.

Activity 1

All modeling is complete. Landscape and forest composition modeling was completed using the LANDIS II model for five forest metrics. Those metrics formed the foundation for habitat quality and water quantity and quality modeling. The WHINGS model was used to generate metrics of habitat quality for six functional groups (e.g., furbearer species) of mammals, five functional groups of birds, and 26 individual mammal species. Seven water quantity and quality metrics were generated. Modeling each of these under 12 unique combinations of management and climate resulted in 588 modeled and mapped metrics for the tool. Additionally, these formed the foundation for generating economic valuation. *(This activity marked as complete as of this status update)*

Activity 2

The tool is complete and is available for public use at mnforcast.org. Users have the ability to compare model output under different forest management and climate scenarios. This includes a calculation of economic value based on a "willingness to pay" for ecosystem services. Reports are automatically generated that reflect the content of the tool and can easily be downloaded as a pdf or shared with a digital link that allows anyone to generate the same information, facilitating communication. We engaged forestry professionals from Minnesota, the US Forest Service, and the University of Maine to review and provide comments on the tool that were incorporated into its development. Additional review and testing was conducted internally with members of the ForCAST team.

Throughout the project, decisions were made and effort was allocated with a goal of limiting future maintenance expenses. A programming framework, `vue.js`, was used to facilitate development, future maintenance, and component updates. All code was thoroughly commented and is being managed in a github repository, ensuring access and also contributing to lower future costs associated with website and tool maintenance.

(This activity marked as complete as of this status update)

Activity 3

This activity was previously marked complete.

(This activity marked as complete as of this status update)

Dissemination

We have begun work to inform the general public, decision makers, and natural resource managers about the ForCAST Tool. John Du Plissis made a presentation at the UMN Sustainable Forestry Education Cooperative's 2025 Forestry and Wildlife Research Review on January 8th, 2025. You can view the presentation online at https://www.youtube.com/watch?v=CEJJ-p5i_Kw starting at 1:03:33. We will be presenting a webinar on the ForCAST Tool through the Sustainable Forestry Education Cooperative on May 13th, 2025 <https://sfec.cfans.umn.edu/events/web25-may>. Du Plissis will be meeting with MN DNR Forestry and Wildlife staff in February to discuss the tool and is working with the executives of the Minnesota County Land Commissioners and Minnesota Forest Resources Council to make presentations to their Boards.

Status Update Reporting

Status Update December 1, 2024

Date Submitted: February 13, 2025

Date Approved: February 18, 2025

Overall Update

See Final Update

Activity 1

See Final Update

Activity 2

See Final Update

Activity 3

This activity was previously marked complete.

(This activity marked as complete as of this status update)

Dissemination

See Final Update

Additional Status Update Reporting

Additional Status Update August 14, 2024

Date Submitted: August 29, 2024

Date Approved: October 16, 2024

Overall Update

The LANDIS II forest composition modeling base results have been completed for all 12 of the unique management and climate scenario combinations. The wildlife habitat modeling team has requested additional LANDIS II outputs that can be generated as a supplement to the base results and additional post-processing of LANDIS II outputs to allow them to more accurately represent the forest age classes for each forest cover type within the WHINGS wildlife habitat quality model. The HSPF water quality and quantity modeling team continue to work on getting LANDIS II output for each of the forested HUC 8 watersheds into the model. The mapping application tool development has made substantial progress, particularly with reporting capabilities. The needs assessment report has been completed and submitted to LCCMR. Tool delivery is still anticipated for November with training and promotion to follow in December.

Activity 1

Extensive evaluation of the LANDIS II model outputs after completing all twelve scenarios revealed that some harvest prescriptions needed slight revisions due to how LANDIS II classified tree communities when only a small percent of trees were left on the landscape. Prescriptions were adjusted and all modeling scenarios have been completed. Initial wildlife modeling using the LANDIS II output paired with additional analysis of the LANDIS II output has prompted a methodology modification for modeling habitat quality. Previously, the wildlife team used max age as a way to represent tree size, which is critical to understanding habitat functionality and quality. Under certain conditions, this has been shown to provide inaccurate characterization of habitat quality. We are in the process of generating additional outputs for the 12 scenarios and changing our post-processing to provide a more functional representation of forest age based on ecological/economic size classes: seedling to sapling, pulp logs, small saw timber, and large saw timber. This change should generate superior wildlife modeling results and will not impact the existing LANDIS II results. Modeling for both wildlife habitat and water quality and quantity should be ready in time to allow for a November launch of the tool.

Activity 2

Report generation functionality has been fully developed, enabling users to create comprehensive and consistent reports for use within and outside of the tool. A strong emphasis was placed on meeting federally mandated accessibility guidelines. An online HTML version of the report, which is easily navigable using assistive technology, was delivered alongside downloadable PDF reports. While PDFs are often preferred for sharing and printing purposes, dynamically generating them in a fully accessible format presented significant challenges. As a solution, downloaded PDFs include a link to the online accessible version.

We are in the process of optimizing LANDIS II model outputs for the web and importing them into the web application's database. The LANDIS II model outputs have been converted into Cloud Optimized GeoTIFFs (COGs), which will enable quick display and data access for the web. The next step will be to load the COGs into the mapping application tool and proceed with testing.

Activity 3

This Activity is complete. The collection and analysis of survey responses, review of results and engagement with stakeholders, and triangulation of results is now complete and the final report has been submitted.

(This activity marked as complete as of this status update)

Dissemination

No work has been started for dissemination.

Training and an awareness campaign will take place from mid-November through the end of December.

Status Update Reporting

Status Update June 1, 2024

Date Submitted: June 5, 2024

Date Approved: June 14, 2024

Overall Update

The LANDIS II forest composition modelers have resolved the unexpected model behavior that occurred while setting and refining harvest prescriptions. The unexpected behavior, which most prominently impacted the process of regeneration of forest stands after harvest, caused significant, unexpected delay and set the entire project back. The first full set of LANDIS II output (all three climate scenarios for the business as usual harvest scenario) has been generated and has been formatted for the habitat and water modeling teams and the tool development team. The remaining three sets of LANDIS II output are expected to be generated over the course of the next 4 weeks. Water and habitat modeling output is expected to lag behind the generation of the LANDIS II output by approximately 2 weeks. Development of the web application has continued concurrently with the LANDIS II modeling work and has relied heavily on data from phase one, which is similar in format but geographically limited, for development and testing.

Activity 1

We have worked through the challenges that we have encountered with unexpected results from the LANDIS II landscape model. Results have been generated for all three climate scenarios under the static harvest management scenario. Work is underway on the other nine management and climate scenario combinations with completion expected in the next 4 weeks. The script for processing LANDIS II results to the format required for habitat modeling and the mapping application has been updated from phase one and successfully run on the first three sets of LANDIS II data. During the week of 5/27, the water modeling group is expected to complete the limited amount of pre-modeling work by finalizing climate data for the few remaining watersheds and start modeling. The habitat modeling group has completed their pre-modeling work and is expected to start modeling the week of 6/3. Once habitat and water results can be provided, the economic modeling will start. LANDIS modeling is expected to be completed by mid-June, habitat modeling is expected to be completed by early August, and water modeling is expected to be completed by mid-September. Economic modeling completion will lag water modeling by a week or two.

Activity 2

Substantial progress has been made in the development of the Map Application. The base structure of the entire tool has been built. Core functionality has been programmed utilizing data from phase one, including 1) area of interest selection, 2) newly designed scenario selection pane that facilitates comparisons across multiple climate and/or forest management scenarios or for multiple modeled outputs, and 3) the results section. Results include 1) narrative summary, 2) trend and distribution plots, and 3) maps and map comparison tools. The server-side of the tool has been reworked into a simpler, more flexible arrangement compared to phase one. Rasters are processed into Cloud Optimized GeoTIFFS. An Application Programming Interface (API) has been developed with data stored in a PostgreSQL database that has PostGIS, Raster, and H3 hexbin support. The API is written in the Python programming language using FastAPI, Gunicorn, and Uvicorn. Report generation, improved comparison capabilities and the revised user interface are expected to be completed by the end of August. All data is expected to be in the tool by the end of September with beta testing taking place in mid-October. The tool is expected to be completed in mid-November.

Activity 3

This Activity is complete. The collection and analysis of survey responses, review of results and engagement with stakeholders, and triangulation of results is now complete and the final report has been submitted.

The Center for Changing Landscape at the University of Minnesota surveyed foresters and natural resource management

professionals from government agencies, industry, habitat conservation management, environmental organizations and tribal governments to discover their values, management decisions, perceived impacts, and future priorities relating to local forest management and climate change. The purpose of this survey was to better understand the forest values, management priorities, and needs of forestry and natural resource professionals to use this information to identify and prioritize future action steps for reaching forest management goals across different regional landscapes. The results of this survey were presented to the Minnesota Forest Resources Council's Regional Landscape Committees for feedback and to provide triangulation of the results. The results from the survey and triangulations were used to help design the harvest scenarios and prescriptions for each of the six land ownership groups modeled as part of the landscape level forest change simulations.

(This activity marked as complete as of this status update)

Dissemination

No work has been started for dissemination. Training and an awareness campaign will take place from mid-November through the end of December.

Status Update Reporting

Status Update December 1, 2023

Date Submitted: October 24, 2023

Date Approved: January 25, 2024

Overall Update

Modeling work continues and progress is being made in spite of a significant challenge implementing harvest prescriptions within the LANDIS modeling. Although all other groups are dependent on receiving LANDIS results to complete their components, effort has been focused on identifying and completing work that can be done without those results to position the groups to be able to move quickly as they become available. This includes making necessary parameterization changes to reflect the larger study area and different species present within those areas, acquiring and modifying climate data, and updating the mapping application prior to receiving results. We continue to engage forestry practitioners to better understand their needs and ensure a user base for the final product.

Activity 1

Substantial challenges were encountered while parameterizing the harvest module within the LANDIS model. For unknown reasons, the models' harvest simulations deviated from current forestry practices. An unexpectedly high number of test model runs and external consultation with LANDIS experts were required to resolve the problem. Currently, our LANDIS work centers around introducing risk via a module that simulates damage and mortality from wind, insects and disease and forest fires. The habitat team has been updating the Habitat Suitability Index values to reflect the additional tree species and species groupings in the expanded study area. The water modeling problem of watersheds spanning the border with Canada has been resolved. Models are prepared, with the exception of the LANDIS data, for 26 of the 31 watersheds That includes downloading climate data and modifying it with local weather station data.

Activity 2

Parallel to the modeling efforts, feedback from phase one of the project and information from a focus group of practitioners held in August is being used to inform changes and updates to the mapping application. Updates to the tool interface include the addition of features enabling users to compare output from different climate scenarios, forest management scenarios, and layer outputs. The prominence of maps is being subtly reduced while emphasizing verbal summaries, graphs, and charts through the development of a tab-based layout. This layout facilitates the generation of reports.

The application's core is being improved by refactoring the backend code, shifting to the Vue.js composition API from the options API, thereby making the codebase more flexible and reusable for future development. The method for delivering the data to the client has been overhauled. Instead of using Geoserver, the architecture has been simplified down to a PostGIS database with a Python API in front of it. Development and testing to deliver raster data via streaming to the client as Cloud Optimized GeoTIFFs is ongoing. Additionally, at the request of our focus group participants, we are reviewing and testing methods for visualizing spatial data with spatial less resolution.

Activity 3

The survey is complete and preliminary analysis of the data has been presented to the Minnesota Forest Resources Council's Northeast Landscape Committee for their review and comment. The comments are being integrated into the analysis and meetings are being set up with other similar groups around the state to continue to improve the analysis and assessment of survey results.

Dissemination

No work has been started for dissemination.

Status Update Reporting

Status Update June 1, 2023

Date Submitted: June 14, 2023

Date Approved: June 15, 2023

Overall Update

All data required to model future forests has been acquired. We have finished parameterizing the LANDIS biomass growth and soil biogeochemical dynamics module and tested model performance at a statewide extent. This process generated an initial data set that the wildlife habitat and water quality and quantity modeling teams can use to test their methods. We are currently parameterizing and testing the timber harvest module. The process of converting LANDIS outputs into the wildlife habitat model inputs is being updated and the parameterization of the water quality and quantity models with climate data is underway. Work continues on the design of both the user interface of the web application and the report generation functionality. The survey of forestry professionals has been conducted and the data are currently being analyzed.

Activity 1

All biological, physical, climate, and ownership/management data were acquired for the LANDIS model. An initial base run was completed. This run included biomass growth and soil biogeochemical dynamics, but didn't include forest fire risk. Remaining work includes completing the parameterization of the harvest module, parameterizing the forest fire module, and applying the finished model, statewide. The water modeling team is working on parameterizing the HSPF models (one for each major watershed in the study area) with climate data. This has been complicated by watersheds that extend into Canada, as available climate data is not consistent with that which is available in the US. The habitat modeling team is working on updating a programming language script that converts the LANDIS outputs into inputs for the WHNGS model.

Activity 2

Work continues on the design of the improved user interface and reporting functionality. The focus of this design work is to outline how comparisons will be made within the application and to determine the standard and elective report components and the process for selecting the elective components.

Activity 3

A survey went out to 488 forestry professionals with the purpose of gathering input from on important forest values, management priorities, and data or information needs. 109 people responded and the results are currently being analyzed. Focus groups will be conducted as a followup to the survey. Initial planning has been completed to center the focus groups around Minnesota Forest Resource Council regional meetings and to increase Tribal representation.

Dissemination

No work has been started for dissemination.

Status Update Reporting

Status Update December 1, 2022

Date Submitted: December 2, 2022

Date Approved: December 5, 2022

Overall Update

Substantial progress has been made in effort to assemble the required biological, physical, climate, and forest management data and parameterize the LANDIS II landscape model. Substantial effort has been put towards evaluating global climate models and emission scenarios and consulting with climate experts to ensure appropriate combinations are chosen. The process of evaluating and choosing appropriate climate model and emission combinations was more challenging than anticipated and required multiple consultations with climate experts and extensive internal evaluation to determine if they were appropriate and available in formats that were compatible with the landscape and water models that we are using. We also evaluated how well they predicted historical climate. Initial work has begun to create report generation capabilities for the interactive map. A survey of forestry professionals is currently being piloted.

Activity 1

Assembly and processing of the biological and physical data required to parameterize the LANDIS II model is nearly complete. Substantial work went towards determining appropriate Global Climate Change models and future emission scenarios. Guidance was provided by the Minnesota Climate Adaptation Partnership and the Minnesota State Climatology Office. Two models were chosen to represent potential future climate conditions. One is hotter without an increase in precipitation and one is hotter with an increase in precipitation. It is anticipated that a test run of the model in a limited geographical area will be completed during the second week of December. NRRI staff also met with U of MN College of Food, Agriculture and Natural Resource Sciences faculty to discuss updates and modifications to the WHINGS wildlife habitat model to improve the Habitat Suitability Index estimate.

Activity 2

Initial work has begun on identifying and developing methods that will expand the functionality of the interactive mapping application. User feedback was solicited and collected during a training workshop held in September for the ForCAST tool from phase one. Additionally, suggestions made during beta testing of the phase one tool that weren't practical to include at that time are under consideration for phase two. To meet the most commonly requested enhancements, planning has begun to enhance the tool's capability for comparing different scenarios and to develop report generation capabilities that align with forest managers' current reporting needs. Initial work is underway to generate html and pdf reports for users. These methods rely on generating the maps from the server, as opposed to the client and continue to rely on open source software packages and programming languages.

Activity 3

Further revisions were made to the survey. The survey has been sent for external review to researchers at the Northern Institute of Climate Science and the US Forest Service Northern Research Station. After review and refinement, the survey will be sent out broadly to foresters, land managers, and tribal resource managers across the state. Special emphasis has been made to ensure broad distribution by using the Minnesota Forest Resources Council planning committees as target groups.

Dissemination

No work has been started for dissemination.

Status Update Reporting

Status Update June 1, 2022

Date Submitted: June 1, 2022

Date Approved: July 1, 2022

Overall Update

Initial work and planning has begun for Activities 1 and 3. However, substantial progress on Activity 1 has been delayed due to a longer than expected process to create a subaward for the foundational work of that activity.

Activity 1

Landscape and forest composition modeling using the LANDIS-II model serve as the foundation of all the modeling for Activity 1. External expertise in the development and parameterization of LANDIS-II models is being brought into the project from the United States Forest Service. Unfortunately, the process of creating the subaward that will allow this work has taken significantly longer than expected, preventing the start of this work and delaying the other modeling components. The habitat and water quality modeling teams have developed plans that should allow them to efficiently model their components at this large scale once the landscape models have been completed.

Activity 2

No work has been started for Activity 2.

Activity 3

A draft of the forest resource professional online survey has been completed and a list has been compiled of forestry and land management professionals that will be requested to take the survey. Next steps are to pilot and refine the survey.

Dissemination

No work on dissemination has been started.