Final Abstract

Final Report Approved on November 12, 2025

M.L. 2022 Project Abstract

For the Period Ending June 30, 2025

Project Title: Land-Use and Climate Impacts on Minnesota's Whitewater River

Project Manager: Andrew Wickert

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Website: https://www.safl.umn.edu/

Funding Source:

Fiscal Year:

Legal Citation: M.L. 2022, Chp. 94, Sec. 2, Subd. 03h

Appropriation Amount: $199,000

Amount Spent: $199,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

Surveys of the Whitewater River valley hold a 170-year record of river and floodplain evolution in response to Euro-American settlement, agriculture, and climate change. We combined disparate paper archives, computer files, and technical reports into an index of river-valley change to guide river management and restoration.

Overall Project Outcome and Results

The Whitewater River valley holds southeastern Minnesota's largest concentration of public lands. Two state parks, sprawling state forest, and a 27,400-acre wildlife management area canvas the river's mouth to the edges of its surrounding uplands. The reason for this uniquely extensive public access holds less romantic appeal: Euro-American settlers, unprepared for the climate and landscapes of the upper Midwest, induced deep and widespread erosion through plow-based agricultural intensification. These eroded sediments deposited across the Whitewater River channel and floodplain, forming 3–15-foot deposits that buried three towns and rendered farming impossible. The state purchased these lands and now is tasked with managing this changed environment in the public interest.

In 1939, 1964, and 1994, government agencies mapped the Whitewater valley through repeat surveys on approximately

94 established valley cross sections. These data show how the valley evolved over nearly a century, making them the likely key towards management and restoration efforts, both in the Whitewater valley and in similar landscapes across the state with similar histories of settlement and agricultural establishment. These data lay scattered among physical field notebooks, typed reports in library archives, and in a set of digital files generated through the largely volunteer efforts of recent NRCS professionals.

We obtained, compiled, geospatially registered, and rigorously error-checked these records. We found and integrated soil-probe measurements from the 1939 survey, where the original surveyors found the ca. 1855 floodplain-soil surface. We digitized airphotos from 1938 to 2021, and from these generated land-use and land-cover maps. These comprehensive data sets, in preparation for journal-article submission, uniquely record long-lived river evolution in response to environmental change. These will underpin future management of the Whitewater River and form a source data set that can be used to effectively plan restoration efforts across the state.

Project Results Use and Dissemination

We developed data sets in portable digital formats and have shared them with project partners and colleagues working in the Whitewater River valley. Linked with these, we built a story map that describes our work and findings for a public audience, including environmental change across the Whitewater valley and development of the data set from 1939 to present. From this work, we published 1 MS thesis, 1 journal article with 1 more in preparation, and two conference presentations. This LCCMR-funded research supported part of our work that was highlighted in Science magazine.

Environment and Natural Resources Trust Fund

M.L. 2022 Approved Final Report

General Information

Date: November 12, 2025

ID Number: 2022-163

Staff Lead: Tom Dietrich

Project Title: Land-Use and Climate Impacts on Minnesota's Whitewater River

Project Budget: $199,000

Project Manager Information

Name: Andrew Wickert

Organization: U of MN - St. Anthony Falls Laboratory

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Project Reporting

Final Report Approved: November 12, 2025

Reporting Status: Project Completed

Date of Last Action: November 12, 2025

Project Completion: December 31, 2024

Legal Information

Legal Citation: M.L. 2022, Chp. 94, Sec. 2, Subd. 03h

Appropriation Language: $199,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the St. Anthony Falls Laboratory to augment, digitize, and disseminate unique and historic topographical survey data showing changes in the Whitewater River valley to inform future land and water management.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: Augment, digitize and disseminate repeat topographic surveys of the Whitewater River valley since 1939, which provide critical information for sustainable land and water management.

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

Starting in the 1800s, Euro-Americans cleared land and plowed for agriculture, eroding fertile hilltop farmland in SE Minnesota. These eroded sediments filled river valleys, badly damaging their ecosystems and causing entire valley-bottom towns to be buried by sediment and abandoned. This problem prompted the formation of the Soil Conservation Service, forerunner of the NRCS; one of their earliest tasks was a 1939 survey of 72 valley cross sections along the Whitewater River and its forks. This early survey was repeated in 1964, 1994, and 2008; to my knowledge, no such detailed river-valley study exists anywhere else in the world. The cross-sections demonstrate river response to agricultural practices, which control the amount of sediment available to deposit in the valley floor; the construction of Lock & Dam No. 5, which raised the water level at the river's mouth and caused extensive sedimentation as the river rose to meet the new water level; and modern changes in climate and agricultural drainage. However, these unique and phenomenal records are not available to managers, scientists, or the public, and are neither organized nor archived in digital form.

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.

We seek to (1) organize, archive, and make available past records of Whitewater-River-valley change; (2) link these cross-sectional surveys with historical airphotos and maps that display river-valley change over time; and (3) augment these surveys with the geometry of the pre-settlement land surface. Towards (1), we will digitally archive all original materials associated with the 1939, 1964, 1994, and 2008 surveys, convert these into a digital (GIS vector) format, and combine these with the new data to be obtained as part of this project; all data will be hosted on UMN servers and explained in a story map. Towards (2), we will use historical maps and overhead photos dating back to the 1850s to record and digitize changes in the river-valley network, river-channel characteristics, vegetation, bluff edges, and wetlands. Towards (3), we will combine ground-penetrating radar surveys with auger borings and sampling for radiocarbon dating to identify, map, and date the buried pre-Euro-American-settlement surface. Upon completion of these three activities, we will present a complete set of geospatial data on the three-dimensional change of the Whitewater River valley in response to Euro-American settlement, changing agricultural practices, dam construction and river-mouth flooding, and ongoing climate and agricultural-drainage changes.

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?

Euro-American modification to the land surface is often cited in terms of environmental policy and water resources, but is rarely quantified. These historical surveys, and our proposed augmentation of these data, will provide a one-of-its-kind data set to evaluate the efficacy of soil-conservation methods, the impacts of climate change, and the effects of lock-and-dam construction on Minnesota's landscape. We hope that scientists and natural-resource managers can study the pace and volume of land-surface and sediment-storage change in the Whitewater River valley to build better decision-making tools for future ecosystem conservation, both within southeastern Minnesota and statewide.

Project Location

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

Watershed(s): Mississippi River - Winona

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

Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Organize, archive, and disseminate geospatial data on river-valley change

Activity Budget: $61,000

Activity Description:
Drs. Wickert, Larson, Blumentritt, and their staff and students will share, organize, and publish all Whitewater Valley survey materials, and will make these easily accessible by building a story map geared towards prospective users and interested community members. These materials include (1) the four historical surveys from 1939–2011 ; (2) our proposed surveys of valley change from airphotos, satellite photos, and historical maps; and (3) our proposed surveys of the pre-Euro-American-settlement surface. We will store these data in 3D GIS vector format and interpolate past valley-floor surfaces to visualize and analyze changes in sediment storage within the valley. These data will be hosted at UMN, along with a story map, which will provide a friendly and educational introduction to the maps and place them in the context of (1) Euro-American settlement and Indigenous-peoples' displacement; (2) landscape change; (3) soil-conservation efforts; and (4) past and ongoing scientific work to improve monitoring and management of Minnesota's lands and waters. Ms. Holger will share this story map and knowledge with Whitewater State Park visitors.

Activity Milestones:

Description	Approximate Completion Date
Disseminate original scans among team	August 31, 2023
Complete organized and geospatially rectified data sets of historical survey data and make available online	May 31, 2024
Digitize past valley-floor surfaces and integrate these into the final repository	August 31, 2024
Integrate new data (airphoto and pre-settlement surface) into the data repository	November 30, 2024
Generate story map for full data set	December 31, 2024

Activity 2: Map river-valley change using historical maps, airphotos, and satellite photos

Activity Budget: $67,000

Activity Description:
Dr. Larson will supervise one MS student (MSU Mankato) who will compile historical overhead photos and maps of the Whitewater River valley. This student will georeference sets of photos or maps as needed from each time that these have been generated, and combine these into a GIS data set that shows changes in the river valley. The PLSS maps extend back to the 1850s, before significant Euro-American impact on the landscape, and are available from the Minnesota Geospatial Commons. The airphotos date back to the 1950s and are available from the DNR. The student will digitize major features, including the river channel, forests, wetlands, and the transition between river bluffs and the valley bottom. Ms. Holger and Mr. Svien will assist the feature identification with their critical local knowledge about the valley history. These digitized maps, as well as the original photos and scans, will be organized into a geospatial database and delivered to the Winona State team in order for them to incorporate these map-view data with the cross-sectional data into the overall repository.

Activity Milestones:

Description	Approximate Completion Date
Download and georeference maps dating back to the 1850s	May 31, 2023
Download and (if needed) georeference high-quality satellite photos	May 31, 2024
Download and georeference airphotos from the dating back to the 1950s	August 31, 2024
Digitize major geographical features	November 30, 2024

Organize and share all data with the Winona State team	December 31, 2024

Activity 3: Map the elevation of the pre-settlement surface

Activity Budget: $71,000

Activity Description:

Using ground-penetrating radar (GPR), real-time kinematic GNSS (highly accurate GPS), and hand augers, Dr. Wickert (UMN), Dr. Larson (MSU Mankato), and one MS student (UMN) will map the elevation of the buried soil beneath the modern sediments. These sediments accumulated as a result of hilltop erosion during Euro-American settlement as well as floodplain aggradation due to the rising Mississippi River waters following the construction of Lock and Dam No. 5. The 1939 surveys obtained the locations of these soils in hand-augered boreholes at the survey endpoints, which Mr. Svien has located, but lack information on the depth to this soil across the valley profile. We are adding these surveys to the data set because the land-surface elevation prior to Euro-American settlement is an essential initial condition to assess the time series of total change to the Whitewater River valley network since Euro-American arrival. We will obtain dates of this soil layer from historical maps and archived information about Euro-American settlement.

Activity Milestones:

Description	Approximate Completion Date
GPR survey the cross sections	October 31, 2023
Ground-truth the GPR data with hand-augered tests	October 31, 2023
Obtain the radiocarbon samples	October 31, 2023
Process the GPR data to generate cross-sectional profiles of the pre-settlement surface	February 28, 2024
Provide the full organized data set to the Winona State group for data-repository integration	April 30, 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Phillip H. Larson	Minnesota State University, Mankato	Ground-penetrating radar; historical mapping	Yes
Dylan Blumentritt	Winona State University	Data digitization, coordination, and dissemination	Yes
Lawrence Svien	Minnesota Board of Water and Soil Resources	Svien located the majority of the original 1939 survey-endpoint monuments in his master's thesis work and over many years before and after. Svien will join us in the field and help us to find these monuments and align our GPR + RTK GNSS transects with them.	No
Sara Holger	Minnesota Department of Natural Resources	Lead Interpretive Naturalist at Whitewater State Park. Holger will help to locate original documents from the 1939 Happ surveys of the Whitewater valley and to disseminate our findings and story map to park visitors.	No

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.
Our dissemination plan comprises three components: (1) accessible and long-term archival data and other associated project outputs, (2) production of a story map for an accessible overview of this work, and (3) direct engagement by Interpretive Ranger Holger.

1. Open publication of all data and other project deliverables via the Digital Repository for the University of Minnesota (DRUM), http://hdl.handle.net/11299/166578. This resource, supported by the University of Minnesota libraries, will provide access to this information in perpetuity. University libraries' curators review all incoming submissions and work with data authors to comply with data sharing requirements in ways that make data FAIR (Findable, Accessible, Interoperable, Reusable). Data files in DRUM are written to an Isilon storage system with two copies, one local to each of the two geographically separated University of Minnesota Data Centers. The local Isilon cluster stores the data in such a way that the data can survive the loss of any two disks or any one node of the cluster. Within two hours of the initial write, data replication to the 2nd Isilon cluster commences. The 2nd cluster employs the same protections as the local cluster, and both verify with a checksum procedure that data has not altered on write. In addition, DRUM provides long-term preservation of digital data files for at least 10 years using services such as migration (limited format types), secure backup, bit-level checksums, and maintains a persistent DOIs for data sets, facilitating data citations. In accordance to DRUM policies, the (deidentified, if applicable) data will be accompanied by the appropriate documentation, metadata, and code to facilitate reuse and provide the potential for interoperability with similar data sets.

2. An explanatory overview of the data, principal findings, and the lessons learned for sustainable management of Minnesota's rivers will be provided via a story map. This story map will provide an accessible introduction to our work and outcomes that is designed to be understandable by stakeholders and community members as well as scientists and decision-makers. It will serve as a partner to the data and materials supplied via DRUM.

3. Direct engagement with the local community, led and enacted by Interpretive Ranger Holger. Ms. Holger will share the findings and their implications, in terms of both the local environment in southeastern Minnesota and the broader reach of these data to help inform river science and sustainable management. She will share our generated story map with Whitewater State Park visitors and serve as a guide through the data collected and knowledge gained. Furthermore, Ranger Holger will continue in her broader work towards engaging the community around Whitewater

State Park, working to grow appreciation of and engagement with the human and environmental history – and future – of the park, the river, and their people and region.

We will acknowledge the Environment and Natural Resources Trust Fund in all presentations, publications, and other media generated from this work. We will use attribution language and/or images as appropriate for the media form. This attribution will be consistent with the ENRTF Acknowledgment Guidelines.

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?

Following project completion, the full set of historic (original and digitized) and newly acquired data will be available for public download from University of Minnesota servers. In addition, the University of Minnesota will host a story map to describe these data through the multiple lenses of: (1) the history of Euro-American settlement and its impact on the landscape and Indigenous peoples, (2) the soil-conservation movement, (3) climate-change impacts on Minnesota's landscapes, and (4) modern science and its application to natural-resource conservation. No further work will be performed, and no further funds will be required to maintain data and web hosting.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Landslide Susceptibility, Mapping, and Management Tools	M.L. 2017, Chp. 96, Sec. 2, Subd. 03i	$500,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Project manager		Coordinate all research teams; support GIS data organization; manage GPR data integration			26.74%	0.06		$10,322	-	-
MS Student		Pre-settlement surface mapping and associated data integration			39.8%	1.38		$60,561	-	-
IT staff		Web server and data organization and management; data and story map hosting			24.1%	0.16		$9,117	-	-
PhD Student		Assess erosion, deposition, and changes in the Whitewater River from historical archives and geospatial data.			46%	0.48		$24,000	-	-
							Sub Total	**$104,000**	**$104,000**	**-**
Contracts and Services										
Minnesota State University, Mankato	Subaward	Dr. Larson's team will provide the GPR, co-assemble historical archive data, map past valley geography using historical maps and overhead photos, and assist in disseminating the project outcomes. They will also collaborate in the field work. Breakdown: Personnel: $82,000 Supplies: $2000 Travel: $1000				1.28		$85,000	$85,000	-
Winona State University	Subaward	Dr. Blumentritt and one undergraduate student will support data acquisition and dissemination. As a major component of this, they will develop the story map to share our findings and the history of Whitewater valley to the broader community.				0.32		$10,000	$10,000	-

		Breakdown: Personnel: $10000								
							Sub Total	**$95,000**	**$95,000**	**-**
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										
							Sub Total	**-**	**-**	**-**
							Grand Total	**$199,000**	**$199,000**	**-**

Classified Staff or Generally Ineligible Expenses

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

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
			State Sub Total	-	-	-
Non-State						
In-Kind	Unrecovered F&A	Support of SAFL facilities where research will be conducted.	Secured	$63,952	$58,962	$4,990
In-Kind	National Science Foundation Grant 1944782	We applied funds from NSF Grant 1944782 awarded to Wickert for research on the Pleistocene history of the Whitewater valley to support our research team's field-work travel. To leverage economy of scale, we simply folded the LCCMR project into these bookings and costs.	Secured	$2,000	$2,000	-
			Non State Sub Total	**$65,952**	**$60,962**	**$4,990**
			Funds Total	**$65,952**	**$60,962**	**$4,990**

Attachments

Required Attachments

Visual Component

File: a7d0e3ab-a4c.pdf

Alternate Text for Visual Component

1. Map of the Whitewater River valley in southeastern Minnesota, showing the impacts of sedimentation and our planned use of historical maps to reconstruct past valley change.
2. Stafford Happ, leader of the original 1939 surveys, demonstrating the depth of burial of the pre-settlement soil surface.
3. Example cross section...

Supplemental Attachments

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

Title	File
SPA Letter	6b7700e7-5d3.doc
Background Check Certification Form	d244fd49-b74.pdf
Cross-sectional data (spreadsheet)	a6d1946b-140.xlsx
MS Thesis. Jimmy Wood. Buried in bluff country: Stream and valley sedimentation in the Whitewater River Valley, Minnesota (USA)	b3eddfe3-aba.pdf
Poster, Seidling Schummer & Hilgendorf: Examining the impact of historic land use change on watershed evolution, Whitewater River watershed, southeastern Minnesota	f25b60bb-60c.pdf
Plots of all digitized and georeferenced cross-section time series	bbe85cc2-85d.pdf
Whitewater River Valley sedimentation: 1855-1994	e53350a5-e62.xlsx
Rowen, J., H. England, P. Larson, A. Brown, J. Wood, A. Wickert, and Z. Hilgendorf (2024). Assessing Historical Planform Channel Change: Whitewater River Basin, Minnesota, USA. GSA Connects, Anaheim, CA, USA.	56d2ff59-dfb.pdf
Modern farming has carved away earth faster than during the ice age	15068872-b0c.pdf
Plow versus Ice Age: Erosion rate variability from glacial–interglacial climate change is an order of magnitude lower than agricultural erosion in the Upper Mississippi River Valley, USA	e9a18eca-bd9.pdf
Draft of Whitewater River journal article	666c839a-09d.pdf
Draft of figures for Whitewater journal article	10009bcd-51b.pdf

Media Links

Title	Link
Story Map: Whitewater Valley, MN. Sato, S., Kadrie, T., Ostermann, K., Wood, J., and Blumentritt, D. (2025).	https://arcg.is/1qir8z0
Whitewater River Planform Change Analysis: England, Hendrick O Brown, Andrew A Larson, Phillip H Hilgendorf, Zach T Rowen, Jayda K 2025-02-21	https://hdl.handle.net/11299/270021

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

1. Provided the budget breakdown for subcontracts to Minnesota State University, Mankato, and to Winona State University
2. Specified the project location to be in the "Mississippi River - Winona" watershed region
3. Uploaded the background check certification form
4. Described dissemination efforts and ENRTF attribution plan

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?

No

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A

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	• Activities and Milestones • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Non-ENRTF Funds Contributed	1. Winona State unable to complete their full component; transferring funds ($37K out of their $47K) and responsibility to UMN ($20K) and MNSU Mankato ($17K). 2. Cancelling radiocarbon dating: We found more accurate ages in the historical records than we would obtain from these dates. Transfer $2K to historical archive work. 3. We supported field travel on external funds; noting these in "Non-ENRTF funds" and moving the earmarked $2K to further support historical archive work.	December 21, 2023	Yes	December 27, 2023
2	Completion Date	Previous Completion Date: 06/30/2024 New Completion Date: 12/31/2024	1) The WSU team could not find suitable students to carry out the project. The MNSU and UMN teams have picked up this work. They need additional time to first complete it and then finish their original project components. (2) Original airphotos needed to be obtained and scanned, and these contained markings that made developing a composite map difficult. The MNSU team designed new software to overcome this and generate maps, which took extra time.	December 27, 2023	Yes	December 28, 2023
3	Amendment Request	• Activities and Milestones	Adjusted deadlines for activities and milestones towards a 31 Dec, 2024, project deadline. This will help the MNSU and UMN teams to (a) cover the WSU portion of the project and (b) complete the manual airphoto scanning and digital integration, both of which were more difficult than expected.	January 4, 2024	Yes	January 11, 2024

Status Update Reporting

Final Status Update February 14, 2025

Date Submitted: June 11, 2025

Date Approved: July 9, 2025

Overall Update
All originally stated project goals have been successfully accomplished. We have also obtained, curated, and now provide multiple additional data sets not in the initial project plan. Dissemination of this work has been broad, through both academic publications and the media. The paper describing the core data set remains in progress.

In the last reporting period, project completion includes final completion of the historical sedimentation data sets and their release in an attachment to this report in spreadsheets and an OGC Geopackage. These data comprise the historical sediment borings and surveys performed 1939–1941, 1964–1968, 1975, 1978, and 1993–1995. Originally when proposing this project, we knew only of the ca. 1939, ca. 1964, and ca. 1994 surveys. Adding the additional data as well as the borings to the pre-settlement soil expanded the data set significantly in both space and time, and significantly extended its utility to understand the impacts of erosion and deposition on watersheds and rivers.

Overall human-induced sedimentation within the Whitewater valley averages 1-3 meters. At present, rivers are cutting back into these deposits, likely as a result of (a) better conservation agricultural practices and/or (b) increases in river discharge due to climate change.

Activity 1
The repeat river-channel cross sectional surveys are now fully georeferenced and digitized. A Geopackage contains all of the cross sections and their associated data, spreadsheets hold ancillary information, and figures display the time series at each cross section. Wood, Wickert, and Larson are preparing a paper for the journal Scientific Data on these historic data. The first draft of the manuscript is close to completion, but it requires revision from the author team. We will continue to bring this to completion after the end of the original project period.

The valley-change photogrammetric surveys and their results are now available from the Data Repository for the University of Minnesota and linked here.

Former PhD student Shanti Penprase contextualized erosion associated with Euro-American settlement, finding that it was approximately 12 times more rapid than the Holocene mean erosion rate and 8 times more rapid than erosion during the Last Glacial Maximum. Penprase's work was published in the journal Geology and was recently the subject of a feature article in Science magazine (see attached PDF and https://www.science.org/content/article/modern-farming-has-carved-away-earth-faster-ancient-ice-sheets).
(This activity marked as complete as of this status update)

Activity 2
Dr. Larson and his team completed and significantly expanded upon the proposed deliverables of Activity 2. Their team found and scanned historical airphotos dataing to 1938-1940, 1951-1954, 1972, 1980, 2003, 2010, and 2021. They also built pre-Euro-American-settlement land-cover maps based on original surveys that were updated using an object-based classification for topographic and spatial characteristics of different biomes. Using this, they produced a time-series of land-cover change, finding both the rapid transition to agricultural land and (more recently) a shift towards expanded forest. The source stitched airphotos have sub-meter resolution.

In addition to these past maps, Larson's team digitized stream-channel change through the entire airphoto record. Their analysis reveal:
(1) Reduced channel-migration rates over time, likely as the river incises
(2) A longer and more sinuous channel through time with meander development following abandonment of agriculture in the valley bottom
(3) No strong change in channel width.

These land-cover maps, river-change rates, and associated data are provided in the linked data set published with the Data Repository for the University of Minnesota.

The poster on land-cover change, presented at the GSA annual meeting in 2024, is uploaded alongside this report.
(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
Contextualizing the excess erosion following Euro-American settlement:
Penprase, S.B., A.D. Wickert, P.H. Larson, J. Wood, I.J. Larsen, and T.M Rittenour (2025, in press): Plow versus Ice Age: Erosion rate variability from glacial–interglacial climate change is an order of magnitude lower than agricultural erosion in the Upper Mississippi River Valley, USA. Geology. https://doi.org/10.1130/G52585.1

Feature report on this study:
Howell, E. (2025) Modern farming has carved away earth faster than during the ice age. Science. 10.1126/science.zycg3qb.

Sharing our findings with Whitewater State Park in a digestible format:
Blumentritt's team (Winona State) completed the story map and delivered it to Whitewater State Park. This includes the overview of the valley's history and specific information about land-use change, valley sedimentation, and CCC efforts.

Former MS student Jimmy Wood, with help from Wickert and Larson, will soon be submitting his full study on the Whitewater River:
Wood, J., A.D. Wickert, and P.H. Larson (2025, in prep), A 140-year record of stream and valley sedimentation in Minnesota’s Whitewater Watershed, United States, Scientific Data.

Additional products are uploaded or linked under "attachments".

Status Update Reporting

Status Update September 1, 2024

Date Submitted: September 8, 2024

Date Approved: September 20, 2024

Overall Update
The primary goal of our project is to develop a one-of-a-kind time series of past land-surface change in the Whitewater River watershed in order to help us understand and predict how ongoing changes to climate and land use might change landscape stability and sustainability. Towards these ends, we did the following:

(1) Performed a data-rescue exercise to acquire, digitize, organize, and geospatially register a time series of past elevation surveys, including auger borings that map the ca. year 1855 surface that corresponds to the time prior to Euro-American settlement.
(2) Scanned and stitched together aerial photographs and maps dating from the 1850s to present.
(3) Developed maps from the 1850s to present of land-cover (i.e., vegetation) distributions across the Whitewater watershed.
(4) Mapped river-channel position and change throughout the historical airphoto record time-series
(5) Began work on a story map to share the history of the site and its changes through time.

Our major goals from now are to:

(6) Complete the story map.
(7) Combine and disseminate all of the digitized data.
(8) Work with Whitewater State Park to share our findings with park visitors and the interested public.

Activity 1
During the past 6-month reporting period, former MS student Jimmy Wood (UMN) completed and delivered the georeferenced cross-sections of the Whitewater River system. This comprises the North, Middle, and South forks of the Whitewater, along with Beaver and Trout Creeks and the downstream mainstem region. The best-estimate date of the pre-settlement soil surface was determined via historical records to be the year 1855. These digitized surveys have not yet been made publicly available online, though we have uploaded cross-section plots here and an open-access scientific publication is in progress. These actions comprise the first three milestones (disseminate scans, geospatial data sets, valley-floor surfaces).

Larson and his team have completed their work on the airphoto scanning and compilation. These are held separately from the remainder of the data due to their great size and associated need for large-volume storage. One of the goals for the next reporting period is to bring these multiple data types together into a single repository.

Blumentritt and his team are currently continuing to make progress on the story map. Final publication and presentation of the story map will require the aforementioned final organization of the new data, comprising both the airphotos and the historical topographic surveys.

Activity 2
The group led by Larson (MNSU) brought Activity 2 close to completion.

(Milestones 1-3) Prior to the past reporting period, Larson's team downloaded and georeferenced historic maps dating

to the 1850s, comprising physiographic and vegetation surveys. Towards Milestone 2, they obtained and scanned physical airphotos from the map library at the University of Minnesota to produce data at a 30-year repeat interval across the watershed and a decadal interval across the river. These data go beyond those available online and (as originally planned for us). Larson's team developed a new method to digitally restore degraded airphotos photos, which they then combined into maps with sub-meter-scale resolution. Towards Milestone 3, Larson's team incorporated satellite data into their study to cover changes during recent times.

(Milestone 4) Major changes in the watershed comprise topography, river morphology, and vegetation patterns. Larson's team used structure from motion to develop digital terrain models, digitized and mapped river-bank changes, and (during a prior reporting period) analyzed vegetation changes from ca. 1855 to present.

(Milestone 5) Due to the large size of the data set, these data have not yet been organized and shared with the Winona State team. Doing this is part of our ongoing work.

Activity 3
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Dissemination
Limited dissemination has been done so far because until now the major work to gather, assemble, and analyze the data has been in progress. Therefore, data dissemination will be a major task for the upcoming reporting period. Here, I list our more specific plans.

We will publish the following data on the Digital Repository for the University of Minnesota (DRUM):
(a) River cross-sectional time series, in both spreadsheet and GIS-data forms;
(b) Historical maps;
(c) Georeferenced and mosaiced historical airphotos;
(d) Changes in river-channel form and position;
(e) Changes in land cover.

Our story map remains in progress via the Winona State team. The unpublished draft, as before, is available here: https://storymaps.arcgis.com/stories/63c71b4f694545cc8dcb52bfe89e968e

Once these aforementioned products are finalized and made available, we will work with Whitewater State Park on a more detailed dissemination plan that involves outreach and visitor engagement.

All final dissemination products will appropriately reference the ENRTF.

Status Update Reporting

Status Update March 1, 2024

Date Submitted: May 27, 2024

Date Approved: June 5, 2024

Overall Update
We have completed reconstructing the cross-sectional surveys from 1851-2011. These are published in Jimmy Wood's MS thesis and in the attached data set, with which we are wroking towards a data publication for a scientific journal.

We have also completed all research with historical airphotos except for their dissemination, thanks to the team at MSU Mankato and new collaborator Dr. Hilgendorf at UW Eau Claire; some data are shown on the attached student poster (Seidling Schummer & Hilgendorf, 2024)

Prof Blumentritt moved most of his funds to MNSU Mankato and UMN to work through the project. These are supporting (a) publication of Wood's research on the cross sections and, more significantly, (b) airphoto compilation and interpretation. Significantly, Andy Brown (MNSU Mankato) and Dr. Zach Hilgendorf (an emerging collaborator from UW Eau Claire through connections from Prof. Larson) have developed a workflow to stitch together these oft-difficult airphotos into composite maps with sub-meter resolution.

Dissemination tasks are underway or are awaiting completion of the data sets; a draft of the story map is available here: https://storymaps.arcgis.com/stories/63c71b4f694545cc8dcb52bfe89e968e

Under each of the Acitivity Updates, changes the since last status report noted as [last status --> current status]

Activity 1
Milestone 1 [In Progress --> Complete]. All original scans have been disseminated, led by Prof. Larson's group (MSU Mankato).

Milestone 2 [In Progress --> Mostly complete]: Larson's group, including their new collaborators (Dr. Zach Hilgendorf, UW Eau Claire), have completed their work on all airphotos. Likewise, Prof. Wickert's group (UMN), and especially former MS student Jimmy Wood, has produced GIS data from all of the historical surveys. These data, being newly produced, have not yet been placed online. We are also working towards publications of these data.

Milestone 3 [In Progress --> Complete]: All airphoto and pre-settlement-surface data are included in our combined data set.

Milestone 4 [In Progress --> Complete]: Jimmy Wood, as part of his MS thesis, published a history of aggradation and incision across the valley network. This is included within the data set.

Milestone 5 [In progress --> Mostly complete]: Prof. Blumentritt's group (Winona State), and in particular, his student Sho Sato, has made progress on this story map. Its current draft is available here: https://storymaps.arcgis.com/stories/63c71b4f694545cc8dcb52bfe89e968e.

Activity 2
Milestone 1 [Incomplete --> Partially complete]: All historical maps have acquired; they are not yet organized or integrated into our database

Milestone 2 [Incomplete --> Complete]: All historical airphotos have been acquired and georeferenced

Milestone 3 [Not started --> Complete]: Recently added collaborator Hilgendorf incorporated data from LANDSAT missions 1, 5, and 8 alongside the airphoto and historical land-cover data to map changes in the physical geography (and especially vegetation cover) of the Whitewater Valley since the 1970s.

Milestone 4 [Not started --> Complete]: The MSU team and Dr. Hilgendorf (UW Eau Claire) finished digitizing land-cover change over the time period of interest. An undergraduate student at UW Eau Claire presented a poster (see attachment) on the historic land-cover change.

Milestone 5 [In progress --> Still in progress]: Data sharing remains ongoing as we work with the Winona State team towards their story map.

Activity 3
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Dissemination
Since our last update, we have:

(1) Finalized Jimmy Wood's MS thesis (attached)

(2) Published a student poster on land-use change since the time prior to Euro-American settlement (Seidling Schummer & Hilgendorf, attached)

(3) Produced a draft story map on changes within the Whitewater valley (Sato & Blumentritt, https://storymaps.arcgis.com/stories/63c71b4f694545cc8dcb52bfe89e968e: also linked in the attachments)

In addition, Jimmy Wood is currently working towards a data publication on the cross-sectional surveys through time.

Status Update Reporting

Status Update September 1, 2023

Date Submitted: December 21, 2023

Date Approved: December 27, 2023

Overall Update
During this second project reporting period (with reference to overall progress), we:
(1) Gathered, organized, and digitized all available records of valley sedimentation since ~1855 via soil-boring records
(2) Scanned historical airphotos and worked towards a method to mosaic them into composite images
(3) Continued work on a story map to share the history of the Whitewater River valley
(4) Computed differences, where possible, between land-surface elevations over time

Transfer of responsibility from WSU, where students to complete the work could not be found, to MNSU and UMN, generated delays:

[Activity 1, Milestone 3; Activity 2, Milestones 1–4] MNSU took over all airphoto scanning and management. Furthermore, most airphotos needed to be scanned from hardcopy and then georeferenced and mosaicked. Our new anticipated completion date is ~April 2024. Importantly, completion of this work predicates generation of land-cover maps, with implications for our overall completion timeline.

[Activity 1, Milestones 2, 4] Because the UMN team (rather than WSU) collected and organized data, they are not yet ready for dissemination (anticipated ~May 2024).

In order to produce a high-quality outcome despite this project change, especially for the airphoto work, we would like to request a 6-month extension through December 31, 2024.

Activity 1
Milestone 2 [in progress]: The UMN team transferred the remaining handwritten survey data to spreadsheets within the original relative coordinate systems of the surveys. They then converted these data into absolute positions, where possible, via linked leveling and GNSS surveys. These data must still be shared online.

Milestone 3 [in progress]: The MNSU and UMN teams acquired and cataloged historical maps, reports, photos, and airphotos. These comprise the collections of the University of Wisconsin–La Crosse, the Winona County Historical Society, and UMN. Scanning remains underway.

Milestone 4 [in progress]: The UMN team finished digitizing these surfaces and calculated sedimentation and/or erosion volumes by differencing the cross sections. These data must still be shared online.

Milestone 5 [in progress]: The MSU Mankato and WSU groups are making progress together towards the story map.

Dr. Blumentritt at WSU has had trouble finding undergraduate students to complete the work. Therefore, the UMN team led data organization and digitization and the MNSU team took over work with historical maps and airphotos. As a result, successful completion of the work will require funds to be shifted to UMN and MNSU to help them finish their project components in addition to those of WSU.

Activity 2
Milestone 1 [incomplete]: Andy Brown (MNSU) has been occupied with the airphoto work and has not yet worked through the historical maps.

Milestone 2 [in progress]: Larson and the MSU team are scanning airphotos, dating back to the late 1930s, at high resolution for integration into a time series of catchment-wide maps. They are obtaining snapshots of the whole catchment every 30 years. Additionally, they are compiling decadal resolution data on the valley bottom as often as the airphoto-survey frequency permits this.

Unfortunately, the variable quality of the archived airphotos and modifications made to them (especially handwriting on them) has thus far made it difficult to mosaic them into these single watershed-scale images. However, the MSU team is making progress on an algorithm that they hope will resolve this issue.

Milestone 3 [not started]: Unclear if satellite imagery will be necessary; will assess once airphoto work is complete.

Milestone 4 [not started]: Feature digitization must follow airphoto compilation; the MSU team is collaborating with Dr. Zach Hilgendorf (remote-sensing expert, UW–Eau Claire) for support.

Milestone 5 [in progress]: Data sharing is ongoing.

Activity 3
Milestones 1–4 [unnecessary]. Wood (UMN), with the help of Blumentritt (WSU), found and compiled records of soil borings from the original 1939 surveys. Now that these are complete, we know that they provide far better information than any modern survey could.

Wood (UMN) and his undergraduate assistants digitized these archival data and provided pre-settlement-surface cross sections for the full set of Happ surveys. He has merged these into the wider data set for direct and quantitative comparison with later land-surface surveys.

Therefore, we are marking this section of the work complete and will not be performing the radiocarbon dating or the GPR surveys. These portions of the work are no longer needed. However, we hope to use the earmarked funds to support personnel, as it did take extra time and expense to digitize and map the 1939 soil-boring survey data.

Milestone 5 [unnecessary]. The UMN and MNSU groups are now managing the data repository.
(This activity marked as complete as of this status update)

Dissemination
Larson, Blumentritt, and MS student Wood have worked with undergraduate students towards towards developing a story map. This work remains in progress

During the prior reporting period, the project team and Boerigter invited Ranger Holger to the University of Minnesota for a panel discussion and seminar at the Saint Anthony Falls Laboratory. A write-up about the event is now available here:
https://cse.umn.edu/safl/events/ghost-valley-sara-holger-lead-interpretive-naturalist-whitewater-state-park
And her presentation can be watched here:
https://www.youtube.com/watch?v=jQFasjaFvG4

Further data-dissemination efforts will follow completion and compilation of the core data set.

Status Update Reporting

Status Update March 1, 2023

Date Submitted: March 1, 2023

Date Approved: March 9, 2023

Overall Update
During this first project reporting period, we:
(1) Gathered, organized, and partially digitized records of valley sedimentation since 1939
(2) Discovered soil-boring records that reveal the shape of the Whitewater valley before Euro-American settlement.
(3) Began assembling and scanning airphotos for decadal resolution studies on the changing Whitewater valley
(4) Began preparing a story map to share the history of the Whitewater River valley
(5) Hosted a panel discussion and seminar with Ranger Holger at the University of Minnesota

Activity 1
The UMN team has photographed and organized most survey archives available from the University of Wisconsin–La Crosse libraries, including writing "readme"-style summaries. We combined these with spreadsheet data from later surveys (from Project Partner Svien). MS Student Wood has written Python code that imports the individual survey data alongside GNSS positions on survey endpoints, georeferences the survey lines, and compares them against one another in time series.

Larson and the MSU team have obtained access to historical airphotos, are in the process of scanning those photos that are not in digital format, and are georeferencing these. These photos are being moasicked at decadal intervals for the Whitewater River drainage basin. Once completed, the MSU team will digitize channel boundaries to measure channel planform change.

Larson and the MSU Mankato team are compiling the initial ArcGIS Story Map, led by an undergraduate student. Blumentritt and the WSU team will expand this Story Map when the undergraduate graduates.

Wood (at UMN) carried out much of this work as part of a reshuffling of tasks between the three institutions; Blumentritt and the WSU team will lead efforts to integrate modern survey data into these historical records during future reporting periods.

Activity 2
Larson, Brown (EARTH Systems Laboratory), and undergraduate students from MSU have obtained historical aerial photos dating back to the late 1930's. Most photos (before 2000's) are not in digital format or georeferenced. These (hundreds of photos) require scanning (MSU has a large-format digital scanner) to create a digital format that allows for photo-mosaicking. Once mosaicked, roughly decadal intervals of aerial photos will be used in GIS for analysis of planform channel change. We expect that photo scanning will be complete by late spring and digitization of Whitewater River channel boundaries will be complete by May 2023.

In addition, the MSU team is collaborating with a UW-Eau Claire team (Dr. Hilgendorf - remote sensing expert - and undergraduate student) to assess land-use change in historical photo records. They have begun analysis of forest and human land-use cover change using GIS.

Activity 3
Wood and Blumentritt found records of soil-boring data from the 1939 surveys that we previously did not know existed. These data have detailed sedimentological descriptions and are, therefore, better sources of information to understand

subsurface sedimentology than ground penetrating radar imagery (GPR). GPR can only produce imagery displaying reflection facies (i.e. changes in subsurface sediment characteristics), but no detail about what, exactly, those reflections represent. In addition, reconnaissance efforts to explore floodplain sediments revealed (commonly) fine-grained sediment deposition near the surface. Silty and clayey sediments can often obscure (attenuate) GPR signals from penetrating deep into the subsurface.

Therefore, instead of obtaining GPR surveys, we will digitize these archive data and provide pre-settlement-surface cross sections for all of the survey lines as they are more accurate and detailed than anything we could obtain from GPR. Finding, digitizing, and georeferencing these data remains a significant and time-consuming challenge, but thus far is providing better results than our original plan.

Dissemination

Larson and MS student Wood, in connection with SAFL Communications Director Boerigter, are guiding undergraduate students towards developing a story map. This work is still in its early stages.

Additionally, the project team and Boerigter invited Ranger Holger to the University of Minnesota for a panel discussion and seminar at the Saint Anthony Falls Laboratory. This has raised awareness of these environmental themes and is serving to broaden and strengthen university–parks collaborations.