

Final Abstract

Final Report Approved on August 4, 2026

M.L. 2020 Project Abstract

For the Period Ending June 30, 2025

Project Title: Voyageurs Wolf Project – Phase II

Project Manager: Joseph Bump

Affiliation: U of MN - College of Food, Agricultural and Natural Resource Sciences

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E-mail: bump@umn.edu

Website: <https://cfans.umn.edu/>

Funding Source:

Fiscal Year:

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 03e

Appropriation Amount: \$575,000

Amount Spent: \$575,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

Using dozens of GPS-collars and hundreds of cameras, we researched summer wolf ecology. Key outcomes include discovering wolf-beaver dynamics and identifying pup survival drivers. These insights refine Minnesota's wildlife management, ensuring conservation strategies for wolves and prey are rooted in rigorous science.

Summary of Project and Outcomes

The Voyageurs Wolf Project addresses a critical knowledge gap in Minnesota's wilderness: the elusive summer behavior of wolves. While winter activity is better-documented, summer predation and pup rearing remained largely a "black box," complicating effective wildlife management.

Project Background & Intended Solution

The project studies the ecology of wolves in the Greater Voyageurs Ecosystem during the ice-free season. By deploying (~36) high-fix-rate GPS collars and a remote camera network (~350), we investigated how wolves interact with their environment, prey, and human stakeholders during the summer months.

Primary Outcomes & Accomplishments

Our research has directly enhanced the conservation of Minnesota's wildlife and land by providing data-driven insights into predator-prey dynamics.

Summer Predation Discovery: We established that beavers are a primary prey for many wolves in summer, reshaping our understanding of boreal forest ecosystems.

Pup Survival Research: We quantified the impact of parental behavior and food scarcity on pup starvation, which is essential for predicting population trends.

Massive Public Engagement: We reached a global audience of 500,000+ followers, fostering public appreciation for Minnesota's natural resources through weekly updates.

Overall Project Significance

The implications for Minnesota's environmental policy are profound. By identifying the temporal patterns of wolf predation, we provide state managers with tools for:

Deer and Beaver Management: Understanding how wolf predation regulates these populations helps maintain forest health.

Outputs are accessible via the project webpage (voyageurswolfproject.org) and dissemination continues via multiple social media platforms. This project is significant because it helps ensure Minnesota's wolf management and conservation strategies are rooted in rigorous science.

Project Results Use and Dissemination

Dissemination items included peer-reviewed publications, professional presentations, annual population reports, and audio-visual media content shared across multiple platforms. Dissemination remains ongoing via social media, website, and annual population reporting.

A highlight of dissemination was working with another ENRTF supported project to produce the following video about the Voyageurs Wolf Project: <https://www.youtube.com/watch?v=edRILfXmMxo>

Digital outreach continues to thrive via weekly updates across five platforms, reaching a combined audience of over 500,000 followers:

Facebook: 312.6K; Instagram: 72.1K; YouTube: 55.6K; X/Threads: 60.5K

Detailed examples are available on the attachments page and



Environment and Natural Resources Trust Fund

M.L. 2020 Approved Final Report

General Information

Date: August 18, 2026

ID Number: 2020-067

Staff Lead: Mike Campana

Project Title: Voyageurs Wolf Project – Phase II

Project Budget: \$575,000

Project Manager Information

Name: Joseph Bump

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

Office Telephone: (612) 624-2255

Email: bump@umn.edu

Web Address: <https://cfans.umn.edu/>

Project Reporting

Final Report Approved: August 4, 2026

Reporting Status: Project Completed

Date of Last Action: August 4, 2026

Project Completion: June 30, 2025

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 03e

Appropriation Language: \$575,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to study summertime wolf predation on deer, moose, and other species in the Voyageurs region to inform management of wildlife. This appropriation is available until June 30, 2025, by which time the project must be completed and final products delivered.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: Wolf predation in summer is almost unknown but critical to deer, moose, wolf, and disease management. We'll measure wolf predation rates on these species and promote Voyageurs' region wildlife.

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

Research need: Before the Voyageurs Wolf Project began, almost nothing was known of the details of summer wolf predation on deer, moose, or other species in MN. Most of what we know about wolf predation is from studies in winter, which does not likely apply to spring, summer, and fall. Phase I of this project documented alternative food sources such as beavers, fish, berries, and laid the foundation for understanding summer wolf predation. Phase II will build on this foundation, with an emphasis on gathering key data on wolf predation that will assist deer and disease management.

Goal & proven success: We will study spring to fall feeding ecology of wolves and measure wolf predation rates on key big games species in an area with abundant alternative food sources, especially beaver. We will evaluate the relationship between beaver abundance and wolf predation rates on moose and deer. We will use cutting edge audio-visual materials to broadly share the ecological story of Voyageurs wolves and Minnesota's Northwoods region. We have developed novel methods to successfully document summer feeding ecology and demonstrated significant outreach success, e.g. NY Times., PBS Nature.

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.

Management of iconic and highly valued Minnesota wildlife: Deer and moose are iconic MN species, with huge economic, recreational, and cultural importance. We know that wherever deer, moose, and wolves coexist, knowledge and understanding of their interactions, and often complex, ecological relationships, are absolutely integral to the most effective and sound management of all three species. Because these species are intricately linked, they have strong influences on each other's population performance (i.e., survival rates and reproductive success), which directly affects annual variation in their numbers (MN DNR 2017). Understanding wolf predation on deer is a key aspect of the Minnesota White-Tailed Deer Management Plan 2019-2028 and is critical to determining the best management for practices for mitigating deer related diseases.

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?

Our specific, direct activities outcomes are to:

1. Determine wolf predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE); applicable across forest regions of MN.
2. Determine beaver populations within each wolf pack in GVE annually.
3. Evaluate the relationship between beaver abundance and wolf predation rates on moose and deer.
4. Create educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem.

Project Location

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

Region(s): NE, NW, Central,

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: Determine wolf food sources and predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE).

Activity Budget: \$300,000

Activity Description:

Packs are determined with remote camera surveys. Within each wolf pack (the number varies annually) whose territory fall in the GVE, we aim to capture and GPS-collar at 1-2 wolves/pack. Wolf kill sites will be identified from clusters of GPS-collar locations (uploaded daily by satellite) and extensive ground crew inspection with proven, novel methods. We will collect—depending on the prey species—samples from kills. Samples include: hair/skin, skull/lower mandible, antlers, castor gland, toe nails, claws, hooves, teeth, leg bones, bone marrow, pelvis, vertebrae, and other miscellaneous remains found at kills. We will extract and section teeth from wolf-killed prey to estimate the age of the prey. Bone marrow from wolf-killed deer and moose will be extracted and dried to determine the percent of fat in the marrow. Castor glands will be dried and weighed to estimate the age-class of wolf-killed beavers. Collectively, these samples will be used to determine diet (e.g. prey proportions), kill rates (i.e. prey items per unit time), prey selection (e.g. sex and/or age of prey compared to availability; poor condition vs good condition). When searching clusters of GPS-locations we will also record instances where wolves waited-in-ambush for beavers.

Activity Milestones:

Description	Approximate Completion Date
Capture and collar ~12 wolves annually for 3 years	June 30, 2025
Estimate wolf predation rates on moose, deer, and beaver.	June 30, 2025

Activity 2: Determine beaver populations within each wolf pack in Greater Voyageurs Ecosystem

Activity Budget: \$15,000

Activity Description:

Annual fall beaver cache surveys will be completed using fixed-wing aircraft. Each active beaver lodge will be identified and mapped using real-time GIS software. Beaver abundance data gathered for this project can be related to other beaver population work done in the GVE from the 1950s-present. Aerial beaver surveys will be used to estimate beaver population density and the location of all active beaver lodges in each wolf pack territory of interest. These surveys will follow the same methods as described in numerous publications (e.g., Gable and Windels 2018, Gable et al. 2020) and internal Voyageurs National Park survey reports.

Data collected includes: 1) Aerial fall cache surveys, 2) Beaver feature (pond, dam, lodge) delineations from aerial photos, 3) Beaver dam and lodge measurements (height, width, volume).

Predation of beavers by wolves is highest during the ice-free period with beaver constituting up to 42% of wolf diet biomass during the ice-free period (Gable et al. 2017, Sidorovich et al. 2017). Despite this, wolf-beaver dynamics remain poorly understood (Romanski 2010, Gable et al. 2016). However, understanding this dynamic has implications, not only for the conservation and management of both wolves and beavers, but also for ungulate populations.

Activity Milestones:

Description	Approximate Completion Date
Estimates of beaver abundance in each wolf pack territory annually.	June 30, 2025

Activity 3: Evaluate the relationship between beaver abundance and wolf predation rates on moose and deer.

Activity Budget: \$230,000

Activity Description:

Beaver abundance varies across the GVE landscape and therefore varies among wolf packs. We will evaluate how differences in the abundance of beavers affects wolf predation rates on moose and deer of different sex and age classes (fawn/calves, yearlings, prime adults, old adults). This will directly assist deer and moose management in Minnesota and is a key metric identified in the Minnesota White-Tailed Deer Management Plan 2019-2028.

Ultimately, dense beaver populations either 1) buffer ungulate populations from wolf predation, thus decreasing wolf predation on ungulate populations; 2) negatively affect ungulate populations by facilitating a numerical response by wolves, thus increasing wolf predation on ungulates (i.e., apparent competition); or 3) do not influence wolf predation on ungulates. To understand the effect of beaver and ungulate densities on wolf densities we will use linear and non-linear modelling strategies. We will first use simple linear regression to model the relationship between ungulate and wolf densities (wolf ~ ungulate), which is currently considered the best model explaining wolf densities. This model will serve as a baseline to compare other models that incorporate the effects of beaver density, i.e. as a linear and non-linear predictors (predictor (wolf ~ beaver + ungulate)).

Activity Milestones:

Description	Approximate Completion Date
Modeling/analysis of predation rates and prey abundance.	June 30, 2025
Formulate management recommendations	June 30, 2025

Activity 4: Create educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem.

Activity Budget: \$30,000

Activity Description:

On an ongoing basis, PI, postdoc, & project biologists will produce material such as captioned photos, videos, social media content, dynamic graphs, maps, illustrations, presentations, and press releases highlighting the natural history of Minnesota wildlife and the unique value of the Greater Voyageurs Ecosystem and Northwoods Minnesota.

We will also disseminate our research via peer-reviewed journals and presentations at regional, national, and international conferences. Additionally, projects members will write popular articles for conservation organizations (e.g., International Wolf Center, Voyageurs National Park Association) and disseminate information through the social media platforms (e.g. Facebook) of organizations such as Voyageurs National Park and Great Lakes Research and Education Center.

Educational material will be shared via project social media. The project started a Facebook page in November 2018 and as of July 30, 2021, over 127,000 people follow this page. We will also maintain a project website for which we create educational content (www.voyageurswolfproject.org). The project will also maintain an Instagram feed (currently has >10,300 followers), a Youtube Channel (currently has >1,860 subscribers), and a Twitter feed (currently has >3,850 followers).

We will continue to work with outlets such as Smithsonian, Scientific American, Washington Post, Associated Press.

Activity Milestones:

Description	Approximate Completion Date
Produce outreach and media materials	June 30, 2025

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.

Outreach Impact and Goals of the Voyageurs Wolf Project:

Our project has put an emphasis on disseminating our work to the public, especially since its formal conception in 2017. In particular, we started actively sharing our work on social media. Doing so has allowed us to reach a large audience (we currently have >120,000 people following the project on Facebook alone). To date, our Facebook content has reached over 30 million people since November 2018. In 2021, our Facebook content reaches an average of ~100,000 people/day. The relatively quick, large following we have received on Facebook was unexpected but confirmed our suspicion that the public is extremely interested in wildlife, wildlife research, and wolf ecology. As a result, we have made it a priority to make outreach a fundamental part of our project. By maintaining our social media presence, we are able to provide information that entertains, engages, and educates the public. Projects such as ours are really the only way that the public can get the kind of information we share. People cannot go out in the forest and start putting GPS-collars on wolves and seeing where they go, and the public doesn't have the time to go purchase and deploy 40 remote video cameras across large expanses of wilderness. However, we have the resources and the abilities to do this. By sharing maps of the travels of GPS-collared wolves along with photos, videos, and other media from the project, we are able to provide the public with information on wolves and other wildlife that they simply could not get another way, and that is where the social value of this work is in our opinion.

In addition, by sharing this information and generating excitement for the work, we are ultimately fostering an appreciation for the habitat that wolves and their prey need. In our case, that habitat is northern Minnesota and specifically, Voyageurs National Park. By capturing and showing a side of Voyageurs that no one ever sees, we are connecting people to wild qualities that really make Voyageurs the national treasure that it is.

We have also been able to expand our outreach through >30 public presentations, >15 radio/tv interviews, and 5 popular articles written by project members since 2018. Further, our work has been covered in >120 newspaper/magazine articles and appeared on national television 5 times since 2018.

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 provide foundational data for wolf, deer, moose, beaver, and disease management. Although three years of support are requested, we view this funding as foundational. ENRTF support for this phase of the Voyageurs Wolf Project will increase the likelihood that the project can continue longer-term. ENRTF funding for this project will help ensure continued support the Department of Fisheries, Wildlife, and Conservation Biology at the University of Minnesota, Voyageurs National Park, Northern Michigan University, Van Sloun Foundation, The Bell Museum, and numerous small donors and volunteers.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Effects of Wolf Predation on Beaver, Moose, and Deer	M.L. 2017, Chp. 96, Sec. 2, Subd. 03I	\$293,000
Mapping Aquatic Habitats for Moose	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 03I	\$199,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount	\$ Amount Spent	\$ Amount Remaining
Personnel										
Joseph K. Bump		Principle Investigator responsible for responsible for overall project management, organizing all personnel across activities, as well as directly supervising and mentoring project post-doctoral researcher and graduate research assistant.			36.5%	0.24		\$45,560	-	-
Full-time Postdoctoral Associate		Field Leader responsible for field work, data management, and analyses required to achieve project Activities. Thomas Gable has been critical to the success of the Voyageurs Wolf Project to date and is committed to continuing with the project under the advising of Bump.			25.4%	3		\$223,740	-	-
Field Biologist		Experienced field technicians are required to complete field work safely and efficiently, e.g. most field activities require at least two individuals.			31.8%	2		\$140,126	-	-
							Sub Total	\$409,426	\$409,426	-
Contracts and Services										
Vectronic Aerospace, Inc.	Professional or Technical Service Contract	Same source GPS-satellite collar data acquisition and service contract; 12 collars/yr for 3 years; ~\$1116/yr/collar. This service is required in order to receive data from GPS-collared animals and maintain data continuity. This contract is compared to other industry estimates to ensure fair pricing.		X		0		\$40,167	\$40,167	-
							Sub Total	\$40,167	\$40,167	-
Equipment, Tools, and Supplies										

	Equipment	GPS-satellite wolf collars; \$3000/collar for 36 collars to maintain 2 collars/pack for 3 years. Includes replacements for lost/damaged collars.	GPS-collars are required to obtain the location data necessary to search clusters and meet project Activities and Milestones. Sole sourcing from Vectronic Aerospace is requested to maintain the same data collection, i.e. data continuity, product reliability, and battery life. We have compared cost estimates across other wildlife collar companies to ensure competitive pricing.					\$69,307	\$69,307	-
							Sub Total	\$69,307	\$69,307	-
Capital Equipment										
		1 utility snowmobile and trailer	The purpose of the snowmobile and trailer is to enable early and late season field work, i.e. efficient movement among field sites across snow covered ground and lakes.	X				\$15,000	\$15,000	-
		Purchase of one vehicle (\$26,100).	The purpose of this expenditure is to provide dedicated transportation capacity to the project. Vehicle purchase for 3 years of fieldwork requiring 45,000 miles of travel for capturing and monitoring study animals.	X				\$26,100	\$26,100	-
							Sub Total	\$41,100	\$41,100	-
Acquisitions and Stewardship										
							Sub Total	-	-	-

Travel In Minnesota										
							Sub Total	-	-	-
Travel Outside Minnesota										
							Sub Total	-	-	-
Printing and Publication										
							Sub Total	-	-	-
Other Expenses										
		Flight time for annual beaver census (\$100/hr) 50 hours/yr for 3 years. Rate for NPS-owned aircraft per Federal govt. guidelines.	The purpose of this expense is cover flight time necessary to complete the beaver census each year.					\$15,000	\$15,000	-
							Sub Total	\$15,000	\$15,000	-
							Grand Total	\$575,000	\$575,000	-

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - Vectronic Aerospace, Inc.	Professional or Technical Service Contract	Same source GPS-satellite collar data acquisition and service contract; 12 collars/yr for 3 years; ~\$1116/yr/collar. This service is required in order to receive data from GPS-collared animals and maintain data continuity. This contract is compared to other industry estimates to ensure fair pricing.	Justification: It is necessary to continue with the same vendor and data contract so there is data continuity in wolf collars, i.e. we can be sure that collar manufacturing performance, and data received are consistent. This contract is compared to other industry estimates to ensure fair pricing.
Capital Equipment		1 utility snowmobile and trailer	We that acknowledge ENRTF policy to return funds to the program if the capital equipment is sold. Justification: Snowmobile use is critical to project objectives (e.g. deploying cameras to monitor pack size) and there is no other efficient means of monitoring wolf packs during winter in remote areas. Additional Explanation : The Voyageurs Wolf Project is a long-term research and management project with the goal continuous operation. The snowmobile and trailer will be dedicated to the Voyageurs Wolf Project for the duration of their useful product life.
Capital Equipment		Purchase of one vehicle (\$26,100).	We that acknowledge ENRTF policy to return funds to the program if the capital equipment is sold. Justification: A field vehicle is necessary to complete all project objectives, e.g. cluster searches, transport field crew, capture wolves, towing. Currently there is not project vehicle. Additional Explanation : The Voyageurs Wolf Project is a long-term research and management project with the goal continuous operation. If a vehicle is purchased, it will be dedicated to the Voyageurs Wolf Project for the duration of their useful product life.

Non ENRTF Funds

Category	Specific Source	Use	Status	\$ Amount	\$ Amount Spent	\$ Amount Remaining
State						
In-Kind	Un-recovered indirect costs (54% MTDC) at the University of Minnesota	Foregone, Un-recovered indirect costs.	Pending	\$292,852	\$292,852	-
			State Sub Total	\$292,852	\$292,852	-
Non-State						
Cash	Van Sloun Foundation, Bell Museum, Voyageurs National Park Association, Rainy Lake Conservancy, Sturgeon River Chapter of the Minnesota Deer Hunters Association and numerous small donors and hardworking volunteers.	Non-State: Donors to the Voyageurs Wolf Project have supported the purchase of boats, motors, and trailers; remote cameras, batteries, and mounting brackets; collars.	Secured	\$48,500	\$48,500	-
Cash	1 National Science Foundation Graduate Research Fellow at the University of Minnesota Department of Fisheries, Wildlife and Conservation Biology 100% FTE for 3 years (\$108,000 salary, \$57,000 fringe and tuition)	Graduate Student Research Assistantship to support project Activities.	Secured	\$165,000	\$165,000	-
In-Kind	National Park Service has supported project management; supplemental wolf monitoring and kill sites visits; field supplies and equipment; boat and vehicle use; housing for personnel; pilot salary and flight costs for winter moose and wolf suveys and fall beaver surveys.	Overall project support	Pending	\$176,000	-	\$176,000
			Non State Sub Total	\$389,500	\$213,500	\$176,000
			Funds Total	\$682,352	\$506,352	\$176,000

Attachments

Required Attachments

Visual Component

File: [cb42f5ba-589.pdf](#)

Alternate Text for Visual Component

Summer wolf predation is almost unknown but critical to deer, moose, wolf, and CWD management. With novel, proven methods, we'll study wolf predation in summer and promote Voyageurs' region wildlife....

Supplemental Attachments

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

Title	File
Bump et al. 2021 Voyageurs Wolf Project - Phase II Revised Graphic.pdf	98761bd4-dee.pdf
VNP_Letter of Support_Bump LCCMR_2021 updated.pdf	e48c3bb4-b2d.pdf
Bump - Background Check Certification Form for ENRTF Funding Recipients	d63bec08-569.pdf
2022-2023 Annual Population report	26d598e5-1db.pdf
VWP Dissemination report 2023	29416d39-960.pdf
Intrinsic and environmental drivers of pairwise cohesion in wild Canis social groups	854249eb-6ff.pdf
Wolf Predation on White-tailed Deer Before, During, and After a Historically Mild Winter in Northern Minnesota	5e2c6ad4-fe1.pdf
Annual Report 2023-2024 VWP	9bfebdee-400.pdf
Beaver Survey results	8dc9a9f2-0fd.png
Insights from a decade of Research in Norther Minnesota, USA	37a4f5d3-753.pdf
Can Wolf Predation Immediately Alter the ForagingBehavior of Beavers?: Video of a Wolf Killinga Foraging Beaver	3ab29914-6e4.pdf
The influence of human presence and footprint on animal space use in US national parks	acea1645-618.pdf
Wolves foraging on berries is likely a widespread behavior in southern boreal ecosystems.	64a55a38-43c.pdf
The single greatest enigma in wolf biology: wolf pup survival	5f8631bf-344.pdf
The Myth of the Lone Wolf: Navigating the Wilderness of Dispersal	dfa1dc43-983.pdf
Wolves and Coyotes in Minnesota: A closer look at two iconic canines	ffce9f1a-036.pdf
Beavers are the primary prey of many wolves for over half the year in a southern boreal ecosystem	5e6e6372-ee1.pdf
Selfish parents, unhelpful adolescents, and starving pups	75f567b6-08c.pdf
How the temporal patterns of wolf predation during summer drive wolf population dynamics	717dcebb-68a.pdf
Physical Condition of White-tailed Deer Killed by Wolves during Summer in Northern Minnesota	cec31704-324.pdf
beaver survey summary	1c8591f4-a94.pdf
MN Wolf Management Plan	f9611aec-79c.pdf

Media Links

Title	Link
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VWP Annual Report 2023 - 2024	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.voyageurswolfproject.org/files/ugd/7cb5d7_1535caa7852a49b48aee6d1251a4e1f5.pdf
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Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Apart from completing the required tasks in the 'Introduction' tab, an update was made to the "Non-ENRTF Funds Contributed" in the budget. Specifically, we were able to recruit and secure funding for a National Science Foundation Graduate Research Fellow at the University of Minnesota Department of Fisheries, Wildlife and Conservation Biology 100% FTE for 3 years. This project dedicated Fellowship adds \$160,000 to the total project value.

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?

Yes

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?

Yes

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	Justification For Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	• Budget • Other • Budget - Personnel • Budget - Professional / Technical Contracts • Budget - Capital, Equipment, Tools, and Supplies • Budget - Non-ENRTF Funds Contributed • Attachments	There is \$38,693.13 available balance in non-capital equipment due to a collar discount we secured. We request that we rebudget the available balance into \$4,167.69 for general services and the remainder into personnel for researchers running the project. This is needed because we have increased our overall effort, using more cameras (>300), have more wolves with GPS collars (~15) hence the general service, and have expanded the study area by ~15%.	May 22, 2025	Yes	May 23, 2025
2	Completion Date	Previous Completion Date: 06/30/2025 New Completion Date: 12/31/2025	LCCMR administrative workaround for final update.	May 23, 2025	Yes	May 23, 2025
3	Completion Date	Previous Completion Date: 12/31/2025 New Completion Date: 06/30/2025	LCCMR administrative workaround for final update.	May 23, 2025	Yes	May 23, 2025
4	Amendment Request	• Budget - Capital, Equipment, Tools, and Supplies • Attachments	Revision requested by LCCMR: "Capital, Equipment, Tools, and Supplies: Please initiate an amendment request to revise the line-item for the vehicle. It should accurately reflect how funds were spent under this line-item, and no longer be presented as one of three options (rental, purchase, or mileage)." Funds were spent to purchase a project vehicle.	February 12, 2026	Yes	February 13, 2026

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: February 12, 2026

Date Approved: February 13, 2026

Overall Update

The Voyageurs Wolf Project studied the summertime wolf predation on deer, moose, and other species in the Voyageurs region to inform management of wildlife.

With GPS collars and remote camera technology, the project met the specific outcomes of the project work plan to reveal surprising insights into how wolves hunt, raise pups, and interact with their environment outside of winter months. Novel findings include that wolves in the Voyageurs National Park area frequently prey on freshwater fish, use berries as starvation food, and via hunting beavers indirectly affect wetlands and forests. The research has also documented how wolves adapt their hunting strategies seasonally, showing remarkable ecological flexibility.

Beyond ecological discoveries, the project has had a wide public impact. Through social media (>500K followers/subscribers) and engaging video footage of wild wolf behavior, it has brought complex wildlife science to a broad audience, increasing public interest in wolf conservation. Additionally, the findings have implications for land and wildlife management, such as understanding the ecological role wolves play in regulating prey populations like beavers, which can impact wetlands and forest structure. Overall, the Voyageurs Wolf Project has contributed both to scientific knowledge and public education, helping perceptions of wolves as intelligent, adaptable

Activity 1

See April additional update for the summary of what was learned about diet, predation rates on deer, moose, and beaver, and prey selection.

For each year of the project, 15-20 packs were determined with remote camera surveys in the study area. Within 6-12 packs each year captured and GPS-collar 1-2 wolves/pack. >2000 wolf kill sites were identified from clusters of GPS-collar locations. We collected >100—depending on the prey species—samples from kills. Samples included: hair/skin, skull/lower mandible, antlers, castor gland, toe nails, claws, hooves, teeth, leg bones, bone marrow, pelvis, vertebrae, and other miscellaneous remains found at kills. Bone marrow from wolf-killed deer were extracted and dried to determine the percent of fat in the marrow. Castor glands used to estimate the age-class of wolf-killed beavers. Collectively, these samples were used to determine diet, kill rates (prey selection (e.g. sex and/or age of prey compared to availability; poor condition vs good condition)). See the attachment on temporal predation for further details.

When searching clusters of GPS-locations we will also recorded >2500 instances where wolves waited-in-ambush for beavers. To date, the project has searched >40K GPS clusters.

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

Activity 2

Annual fall beaver cache surveys were completed using fixed-wing aircraft each year. Each active beaver lodge was identified and mapped using real-time GIS software. In 2024 the beaver population in the park decreased by 2% from 740 active lodges (1.39 lodges/square km) in 2023 to 724 active lodges (1.36 lodges/square km) in 2024. However, lodges on the central Kabetogama Peninsula increased by about 1 percent.

See attachments for some graphs below showing the changes in beaver density (active lodges per square kilometer) in

VNP based on all aerial survey data collected in VNP to date.

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

Activity 3

Beaver abundance was determined to vary in GVE landscape and therefore varies among wolf packs. We evaluated how differences in the abundance of beavers potential affects wolf predation rates on moose and deer. To date, we do not have evidence that beaver abundance affects the predation dynamics of wolves on deer and moose at the population or landscape level.

PREVIOUS UPDATE SHOULD HAVE READ (April 8, 2025): "The Voyageurs Wolf Project has NOT found a strong relationship between beaver abundance and wolf predation rates on moose and deer."

We have not detected that beaver predation negatively affect ungulate populations by facilitating a numerical response by wolves, thus increasing wolf predation on ungulates. Preliminary, it appears that beaver predation does not influence wolf predation on ungulates. Caution that this is a preliminary interpretation of limited data. To sufficiently understand the effect of beaver and ungulate densities on wolf densities continued data collection is required.

Finding: Winter conditions are main factor influencing deer populations. Moose predation is so low it precludes assessment until it rises; recovery timeline is unknown. Results communicated to MN DNR when project PI was invited member of Wolf Technical Committee 2020-2022; see attached MN Wolf Management Plan recommendations.

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

Activity 4

On at least a monthly, if not weekly, basis, project team members produced material such as captioned photos, videos, social media content, dynamic graphs, maps, illustrations, presentations, and press releases to highlight the natural history of Minnesota wildlife and the unique value of the Greater Voyageurs Ecosystem and Northwoods Minnesota. These were shared via social media (>500K followers/subscribers) to a broad audience and global audience, increasing public interest in wolf conservation and knowledge of northern Minnesota.

We published research via peer-reviewed journals (see attachments) and professional presentations at regional, national, and international conferences (see attachments). Additionally, projects members wrote popular articles for conservation organizations (e.g., International Wolf Center, Voyageurs National Park Association). See attachments for select examples.

See the Dissemination update for further details on how educational materials that were created for outreach to the general public were shared to promote of Minnesota wildlife and the Greater Voyageurs Ecosystem.

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

Dissemination

Dissemination has been sustained and successful. Please see attachments page for select examples.

Since the last update, members of the Voyageurs Wolf Project gave the following presentations at the Wolves Across Borders (June 2-6, 2025 | Lunteren, the Netherland) meeting:

1. Insights from a decade of Research in Northern Minnesota, USA
2. Beavers are the primary prey of many wolves for over half the year in a southern boreal ecosystem
3. Selfish parents, unhelpful adolescents, and starving pups
4. How the temporal patterns of wolf predation during summer drive wolf population dynamics
5. Ending the cycle of endless conflict: four years of keeping wolves off a cattle ranch in Minnesota, USA

Weekly social media updates completed on the following platforms:

Facebook - 312.6K followers; <https://www.facebook.com/VoyageursWolfProject/>
Instagram - 72.1K followers; <https://www.instagram.com/voyageurswolfproject/?hl=en>
X - 44.8K follower; <https://x.com/voyawolfproject?lang=en>
Threads - 15.7K followers; <https://www.threads.com/@voyageurswolfproject>
YouTube - 55.6K subscribers; <https://www.youtube.com/c/VoyageursWolfProject>

Website: <https://www.voyageurswolfproject.org/>

Additional Status Update Reporting

Additional Status Update August 14, 2025

Date Submitted: May 22, 2025

Date Approved: May 23, 2025

Overall Update

Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Activity 1

Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Activity 2

Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Activity 3

Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Activity 4

Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Dissemination

Per LCCMR staff guidance, due to system logic, this is place holder text for the final update to be submitted in August 2025.

Additional Status Update Reporting

Additional Status Update April 8, 2025

Date Submitted: May 22, 2025

Date Approved: May 23, 2025

Overall Update

Project activities/outcomes progressed on schedule to be completed as planned. Since last October we worked steadily through winter to determine wolf predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE). We are on track and preparing for another summer field season. We added thousands of points to our predation data set. We completed another beaver populations survey within each wolf pack in the GVE each year of the project. We have collected significant data as expected to be able to evaluate the relationship between beaver abundance and wolf predation rates on moose and deer. We continue to generate educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem.

This update is being submitted because on the project there is \$38,693.13 available balance in non-capital equipment due to a collar discount we secured. We request that we rebudget the available balance into \$4,167.69 for general services and the remainder into personnel for researchers running the project. We were working with Noah Fribley, request made 10/02/2024 12:58 PM.

Activity 1

Wolf Diet Composition: In the summer months, beavers constitute a substantial portion of the wolf diet, comprising up to 42% of their intake from April to October. This preference is attributed to beavers' availability and the relative ease with which wolves can ambush them, as opposed to the more challenging and risky pursuit of moose or deer.

Predation Rates on Moose and Deer: Despite the abundance of beavers, wolves in the park exhibit minimal predation on moose and deer during the warmer months. Out of over 800 documented wolf kills, only three involved moose, and the majority were beavers or deer fawns. This pattern suggests that wolves may prefer less formidable prey when available.

Impact on Beaver Populations: Even with wolf predation, beaver populations have shown resilience, with numbers increasing by 43% the following year.

Broader Ecological Implications

The interplay between wolves, beavers, and other prey species like moose and deer highlights the complex dynamics within the park's ecosystem. While wolves' predation on beavers may reduce pressure on moose and deer populations, it also influences the landscape by affecting beaver-created wetlands. Continued research is essential to fully understand these interactions and their long-term ecological consequences.

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

Activity 2

This activity was previously marked complete.

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

Activity 3

The Voyageurs Wolf Project has found a strong relationship between beaver abundance and wolf predation rates on moose and deer. When beavers are abundant, wolves focus much of their hunting effort on them—beavers may be easier to catch and pose less risk than large prey like moose or adult deer. As a result, wolves kill fewer moose and deer when beaver numbers are high, although moose density in our study system is low. This shift in prey preference may reduce predation pressure on moose and deer populations, potentially benefiting their survival, especially moose calves. Conversely, if beaver numbers decline, wolves may be forced to hunt more moose or deer, increasing predation

pressure on those species.

Human-induced changes to the landscape have significantly impacted wolf hunting patterns. Wolves disproportionately hunt and kill deer fawns in recently logged areas, likely because these clear-cut forests provide dense stands of young saplings that supply prime food for deer and excellent hiding spots for newborn fawns. Wolves tend to kill deer fawns closer to human infrastructure. Wolves preferentially hunt fawns near linear features like roads, powerlines, and trails, as these corridors facilitate easier movement and may help wolves detect prey.

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

Activity 4

Educational material continue to be shared via project social media. Please see previous status update from first of this month.

Weekly social media updates completed.

Social Media audience:

Facebook - 294K followers

Instagram - 67K followers

X - 44K follower

Threads - 14K followers

YouTube - 51K subscribers

Dissemination

Great Lakes Wolf Symposium presentations:

- 1 "Born to Die: Pack and Population Level Estimates of Wolf Pup Survival and Recruitment in the Greater Voyageurs Ecosystem"
- 2 "Differential provisioning roles, prey size, and prey abundance shape the dynamic feeding behavior of a social carnivore"
- 3 "Wolf-proof Fences for Dummies"
- 4 "Do wolves adjust their predation behavior when hunting deer fawns near human infrastructure?"
- 5 "Video of wolf predation on a foraging beaver: insight into how wolves influence beaver foraging?"
- 6 How the temporal dynamics of wolf predation during summer are shaped by resource pulses, prey availability, and pup-rearing demands"
- 7 "Wolves foraging on berries is likely a widespread behavior in southern boreal ecosystems"
- 8 "How black bear hunting influences the time budgets and foraging behavior of gray wolves"
- 9 "One man's trash: impacts of anthropogenic food subsidies on foraging behavior of gray wolves"

Weekly social media updates completed.

Social Media audience:

Facebook - 294K followers

Instagram - 67K followers

X - 44K follower

Threads - 14K followers

YouTube - 51K subscribers

Website: <https://www.voyageurswolfproject.org/>

Select press:

"A clever wolf repeatedly snuck into a Minnesota ranch. Biologists figured out its MO." by The Minnesota Star Tribune.
Nov.

Status Update Reporting

Status Update April 1, 2025

Date Submitted: May 22, 2025

Date Approved: May 23, 2025

Overall Update

All activities/outcomes progressed on schedule to be completed as planned. Since last October completed another field season to determine wolf predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE). We continued monitoring through winter and will start another summer field season. We added thousands of points to our predation data set. We completed another beaver populations survey within each wolf pack in the GVE each year of the project. We have collected significant data as expected to be able to evaluate the relationship between beaver abundance and wolf predation rates on moose and deer. We continue to generate educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem. We released another wolf population report (see Attachments) for the Greater Voyageurs Ecosystem. Numerous project findings were presented at the Great Lakes Wolf Symposium in late October 2025. We are scheduled to disseminate results at the Wolves Across Borders meeting in June. We continue to publish results in peer-review journals (see Attachments) and our social media dissemination remains strong.

Activity 1

For the past four ice-free seasons we have successfully captured and GPS-collar 1-2 wolves/pack. Over 10,000 clusters of GPS-collar locations were identified. Every cluster per collared wolf was inspected by trained techs with proven methods. We will collect—depending on the prey species—samples from kills. Samples include: hair/skin, skull/lower mandible, antlers, castor gland, toe nails, claws, hooves, teeth, leg bones, bone marrow, pelvis, vertebrae, and other miscellaneous remains found at kills. Bone marrow from wolf-killed deer and moose were extracted and dried to determine the percent of fat in the marrow (ongoing). Castor glands were collected & dried and weighed to estimate the age-class of wolf-killed beavers. Collectively, these samples are currently being used to determine diet (e.g. prey proportions), kill rates (i.e. prey items per unit time), prey selection (e.g. sex and/or age of prey compared to availability; poor condition vs good condition). With these data we were also co-authors able to contribute to a synthetic study of canid cohesion (see Attachments). We continued to maintain a remote camera array of 250-300 cameras year round. *(This activity marked as complete as of this status update)*

Activity 2

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

Activity 3

We were once again able to gather information on beaver abundance across the GVE landscape and these data are being assessed and integrated with wolf pack data for another season. The beaver population in the park decreased by 2% this last year from 740 active lodges (1.39 lodges/square km) in 2023 to 724 active lodges (1.36 lodges/square km) in 2024. However, lodges within the national park boundary remained stable. In the attachments are some graphs showing the changes in beaver density (active lodges per square kilometer) in Voyageurs National Park based on all aerial survey data collected to date. These efforts and data continues to allow us to evaluate how differences in the abundance of beavers affects wolf predation rates on moose and deer of different sex and age classes (fawn/calves, yearlings, prime adults, old adults). We have successfully gathered another year of data to understand the effect of beaver and ungulate densities on wolf densities.
(This activity marked as complete as of this status update)

Activity 4

On an ongoing basis, PI, postdoc, & project biologists continued to produce material such as captioned photos, videos, social media content, dynamic graphs, maps, illustrations, presentations, and press releases highlighting the natural history of Minnesota wildlife and the unique value of the Greater Voyageurs Ecosystem and Northwoods Minnesota. We also disseminated our research via peer-reviewed journals and presentations at a regional conference.

This project was also a key subject/participant in one of the eight videos I produced last spring/summer/fall for the Science Museum of Minnesota to showcase projects funded by the LCCMR // ENRTF. This participation required significant free effort and time. See <https://new.smm.org/lccmr-stories>

See Dissemination Update for further details on Activity 4

Dissemination

Great Lakes Wolf Symposium presentations:

- 1 "Born to Die: Pack and Population Level Estimates of Wolf Pup Survival and Recruitment in the Greater Voyageurs Ecosystem"
- 2 "Differential provisioning roles, prey size, and prey abundance shape the dynamic feeding behavior of a social carnivore"
- 3 "Wolf-proof Fences for Dummies"
- 4 "Do wolves adjust their predation behavior when hunting deer fawns near human infrastructure?"
- 5 "Video of wolf predation on a foraging beaver: insight into how wolves influence beaver foraging?"
- 6 How the temporal dynamics of wolf predation during summer are shaped by resource pulses, prey availability, and pup-rearing demands"
- 7 "Wolves foraging on berries is likely a widespread behavior in southern boreal ecosystems"
- 8 "How black bear hunting influences the time budgets and foraging behavior of gray wolves"
- 9 "One man's trash: impacts of anthropogenic food subsidies on foraging behavior of gray wolves"

Weekly social media updates completed.

Social Media audience:

Facebook - 294K followers

Instagram - 67K followers

X - 44K follower

Threads - 14K followers

YouTube - 51K subscribers

Website: <https://www.voyageurswolfproject.org/>

Select press:

"A clever wolf repeatedly snuck into a Minnesota ranch. Biologists figured out its MO." by The Minnesota Star Tribune. Nov.

Status Update Reporting

Status Update October 1, 2024

Date Submitted: May 22, 2025

Date Approved: May 23, 2025

Overall Update

We continue to make excellent progress towards achieving our activities outcomes. Since last April we smoothly began another field season to determine wolf predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE); applicable across forest regions of MN. The summer field season will conclude soon, by the end of November. We will have added thousands of points to our predation data set. We are primed to determined beaver populations within each wolf pack in the GVE each year of the project. We fly a test flight recently and the prolonged warm temperatures have delayed fall onset and we will survey beavers later in the month. We are collecting the necessary data as expected to evaluate the relationship between beaver abundance and wolf predation rates on moose and deer. We continue to generate educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem. We have drafted another wolf population report for the Greater Voyageurs Ecosystem and will release it soon. Numerous project findings are scheduled to be presented at the Great Lakes Wolf Symposium in October.

Activity 1

Since the last update, this activity has proceeded smoothly. We continued to maintained a remote camera array of 250-300 cameras throughout the summer. Pack size was determined with remote camera surveys and this allowed us to gather extensive information on pack size. Within each wolf pack (the number varies annually) whose territory fall in the GVE, we aim to capture and GPS-collar at 1-2 wolves/pack. Numerour kill sites will were identified from clusters of GPS-collar locations. We will collected samples from kills. We will extracted and sectioned teeth from wolf-killed prey to estimate the age of the prey. Bone marrow from wolf-killed deer and moose was extracted and dried to determine the percent of fat in the marrow. Although this activity focuses on predation, we are also able to estimate wolf population density, and estimate key population parameters including pack size, pack composition, recruitment of wolf pups, and territory size.

Activity 2

This activity was previously marked complete.

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

Activity 3

We were once again able to gather information on beaver abundance across the GVE landscape and these data are being assessed and integrated with wolf pack data for another season, 2024. This continues to allows us to evaluate how differences in the abundance of beavers affects wolf predation rates on moose and deer of different sex and age classes (fawn/calves, yearlings, prime adults, old adults). We have successfully gathered another year of data to understand the effect of beaver and ungulate densities on wolf densities.

Activity 4

Since the last update we have successfully generated content for broader impacts and outreach. On an ongoing basis we have produces material such as captioned photos, videos, social media content, dynamic graphs, maps, illustrations, presentations, and press releases highlighting the natural history of Minnesota wildlife and the unique value of the Greater Voyageurs Ecosystem and Northwoods Minnesota.

We have worked with the press to highlight this project and the value of ENRTF more broadly. See:

<https://www.minnpost.com/environment/2024/09/understanding-the-environment-and-natural-resources-trust-fund-on-the-minnesota-ballot/>

We spent a large amount of volunteer time this summer working with the Minnesota Science Center to help them highlight ENRTF projects and a broader showcase of the value of work supported by this fund.

We also continue to successfully disseminate our research via peer-reviewed journals and presentations at regional, national, and international conferences. Additionally, projects members have written popular articles for conservation organizations and disseminated information through the social media platforms.

Dissemination

The dissemination and impact and goals of the Voyageurs Wolf Project continue to be a top priority and to be successful. Since the last reporting period we have provided social media updates about the project weekly on multiple platforms (e.g. Facebook, Instagram, Youtube). Our social media followers total >400K across platforms.

We have also published multiple peer-reviewed paper since our last update. We about to release another annual population report. Please see the updated project website for extensive materials:
<https://www.voyageurswolfproject.org/>

We successfully launched an art and science exhibit with the International Wolf Center and have prepared multiple talks and posters for the Great Lakes Wolf Symposium later this month.

Status Update Reporting

Status Update April 1, 2024

Date Submitted: June 10, 2024

Date Approved: July 12, 2024

Overall Update

We are making excellent progress towards achieving our activities outcomes. We smoothly began another field season to determine wolf predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE); applicable across forest regions of MN. We successfully determined beaver populations within each wolf pack in the GVE each year of the project. We are collecting the necessary data as expected to evaluate the relationship between beaver abundance and wolf predation rates on moose and deer. We continue to generate educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem.

Activity 1

Since the last update, this activity has proceeded smoothly. We maintained a remote camera array of 25-300 cameras. Pack size was determined with remote camera surveys. Within each wolf pack (the number varies annually) whose territory fall in the GVE, we aim to capture and GPS-collar at 1-2 wolves/pack. Numerous kill sites were identified from clusters of GPS-collar locations. We will collect samples from kills. We will extract and section teeth from wolf-killed prey to estimate the age of the prey. Bone marrow from wolf-killed deer and moose was extracted and dried to determine the percent of fat in the marrow.

Activity 2

Another annual fall beaver cache surveys was completed successfully using fixed-wing aircraft. Each active beaver lodge was identified and mapped using real-time GIS software. The data from aerial beaver surveys has been used to successfully estimate beaver population density and the location of all active beaver lodges in each wolf pack territory of interest.

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

Activity 3

Beaver abundance across the GVE landscape were integrated with wolf pack data. This continues to allow us to evaluate how differences in the abundance of beavers affects wolf predation rates on moose and deer of different sex and age classes (fawn/calves, yearlings, prime adults, old adults). We have successfully gathered another year of data to understand the effect of beaver and ungulate densities on wolf densities.

Activity 4

Since the last update we have successfully generated content for broader impacts and outreach. On an ongoing basis we have produced material such as captioned photos, videos, social media content, dynamic graphs, maps, illustrations, presentations, and press releases highlighting the natural history of Minnesota wildlife and the unique value of the Greater Voyageurs Ecosystem and Northwoods Minnesota. We developed an exhibit with International Wolf Center titled, "Starvation, Adaptation and Survival—Insights from the Voyageurs Wolf Project."

We also continue to successfully disseminate our research via peer-reviewed journals and presentations at regional, national, and international conferences. Additionally, project members have written popular articles for conservation organizations and disseminated information through the social media platforms.

Dissemination

The dissemination and impact and goals of the Voyageurs Wolf Project continue to be a top priority and to be successful.

Since the last reporting period we have provided social media updates about the project weekly on multiple platforms (e.g. Facebook, Instagram, Youtube). Our social media followers total >350K across platforms.

We have also published multiple peer-reviewed paper since our last update. We have also release another annual population report. Please see the updated project website for extensive materials:

<https://www.voyageurswolfproject.org/>

Status Update Reporting

Status Update October 1, 2023

Date Submitted: January 4, 2024

Date Approved: February 13, 2024

Overall Update

1. Determine wolf predation rates on beavers, adult and calf moose, and adult and fawn deer: Each year we collect another round of data on predation rates. Cumulatively we have always been successful in collecting these data and this past summer was no different. In a month we will complete another field season with 2023 predation rate data successfully recorded.
2. Determine beaver populations within each wolf pack in GVE annually. Cumulatively we have never missed a beaver survey year and we are on track for the same this year. Beaver surveys will begin the first week of October, i.e. flights are scheduled we do not anticipate any issues. This year we have made significant progress towards developing our survey capacity (new survey tablets and software) and expanding in collaboration with other NPS units.
3. Evaluate the relationship between beaver abundance and wolf predation rates on moose and deer. This analysis requires long term data, which we are on track to collect.
4. Create educational material for outreach to the general public and promotion of Minnesota wildlife: This effort is ongoing and continues to be successful via multiple methods. For example, we recently published a Star Tribune commentary.

Activity 1

Since the last update we have completed another successful fall field season and begun the winter field season. A team of ~8 full time members has worked throughout the summer and until mid November 2023 to collar wolves, follow their movements, and visit clusters of locations to determine another year's data on wolf predation rates on beavers, adult and calf moose, and adult and fawn deer. This included 8 wolf pack home ranges/territories. A remote camera array of approximately 200 cameras has been continuously maintained during the reporting period, which is key to the work done and progress made. From the remote camera data we will be able to study key aspects of wolf natural history (e.g. pup survival rates) and estimate population sizes.

Activity 2

We successfully conducted aerial beaver censuses in all known wolf pack territories (i.e. packs where at least 1 wolf was collared) in and around Voyageurs National Park. All surveys will be flown in a 2-seat tandem Top Cub at 600–700 ft. above the ground at a speed of approximately 70 mph. Active beaver colonies are identified based on the presence of a food cache next to a lodge, fresh cuttings, or fresh mud on a lodge or dam. During the survey we will record all active beaver lodge locations using real-time Geographic Information Systems software on a computer. The census is expected to be done in about 30 hours of flight time over the course of 7 days. Following the census we will assess the data to estimate the beaver density in wolf pack territories using the combination of our beaver census results and our wolf location data.

Activity 3

This analysis is ongoing. We will analyze the relationship between beaver abundance and wolf predation on moose and deer using the data collected for Activities 1 and 2. We are still analyzing the data collected from the 2020-2022 field seasons regarding wolf kill and predations rates of moose and deer. Once we have these estimates, we will estimate the beaver abundance in each of these pack's territories. Once we have estimates of wolf pack kill rates of moose and deer, and estimates of beaver abundance in these wolf pack territories, we can examine whether higher beaver densities lead to lower kill rates of moose and deer. Ultimately, to address this question, we will need to wait until the end of the 2025 field season as we need to increase of sample size markedly to examine any pertinent ecological trends.

Activity 4

Cumulatively we have published 24 peer-reviewed publications, given ~40 presentations, and maintain ~33 data collaborations with researchers from other agencies, NGOs, and universities. The four social media platforms that we maintain have a combined following of ~350K followers. To date this project has resulted in >425 news and magazine articles, most recently a commentary in the Star Tribune that attracted lots of attention. The project has been featured on approximately 11 radio shows, 4 TV appearances. In order to accomplish our field work, we maintain communication and have permissions from ~115 landowners around Voyageurs National Park.

Dissemination

Overall the project is proceeding smoothly, with actual accomplishments meeting or exceeding objectives. Please attached dissemination document.

Status Update Reporting

Status Update April 1, 2023

Date Submitted: March 31, 2023

Date Approved: May 1, 2023

Overall Update

Our last reporting date for this project was October 2022. Since that time we successfully completed the summer and winter field seasons and the 2021-2022 Wolf Pack and Population Size Report. During 2021-2022, we intensively studied 9 wolf pack home ranges/territories and estimated the size of 14 wolf packs based on an average of 7.3 independent observations of each pack at the estimated size (i.e., the number of wolves we determined were in a given pack). For 9 packs we were able to 1) determine wolf predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE), 2) determine beaver populations within each wolf pack, 3) collect another year of data to help evaluate the relationship between beaver abundance and wolf predation rates on moose and deer, and we 4) continued to create educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem. The most recent effort in terms of number

of packs and territories studied — tied 2020-2021 as the most intensive survey effort to date in the Greater Voyageurs Ecosystem, Minnesota

Activity 1

Significant progress was made to determine wolf predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE). Thousands of clusters of GPS locations were visited to gather data to calculate predation rates. This was done for 9 different packs. This activity is two-thirds complete.

Activity 2

An annual aerial flight to determine beaver populations within each wolf pack was completed in the fall of 2022. This activity is two-thirds complete.

Activity 3

We successfully collected another year of data to help evaluate the relationship between beaver abundance and wolf predation rates on moose and deer. Progress on this activity adds to the robust, longterm data needed to adequately assess this relationship.

Activity 4

We continued to create educational material for outreach to the general public and promotion. In 2022 through to this reporting period we have:

- prepared 13 peer-review papers
- gave 16 public presentations
- shared data for MN DNR wolf population estimate
- reached >25 million people via social media
- gave 5 invited presentations and webinars
- prepared 20 research presentations or posters
- received coverage in 94 popular articles in local, regional, national, and international news outlets, including the Wall Street Journal, Newsweek, The Independent, Minneapolis Star Tribune.

Dissemination

Please see Activity 4 Update. Additionally, we prepared the 2021-2022 Wolf Pack and Population Size Report (36 pages)

and disseminated copies widely, i.e. LCCMR, MN DNR, USFWS, NPS, USFS, International Wolf Center, Tribal Resources Managers, Voyageurs Conservancy, and various NGOs.

Status Update Reporting

Status Update October 1, 2022

Date Submitted: October 1, 2022

Date Approved: October 11, 2022

Overall Update

We have made excellent seasonal progress towards outcome #1, determining wolf predation rates on beavers, adult and calf moose, and adult and fawn deer for each of the wolf packs that in the Greater Voyageurs Ecosystem (GVE). In the 2022 summer field season we have followed approximately 9 wolves across 5 packs, recording predation rates for all major prey species. Outcome #2, determining beaver populations within each wolf pack in GVE annually, will occur in October (this month) and is on schedule both in terms of pilot support and fair weather. We have collected excellent data that will contribute to outcome #3, evaluating the relationship between beaver abundance and wolf predation rates on moose and deer, but this evaluation requires multiple more years of data to adequately assess. Our social media output has been excellent and we have been fortunate to garner sustained press coverage, which continues to meet outcome #4, creating educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem.

Activity 1

Our 2022 field season began in April and will conclude at the end of October. It has been a successful effort: we collared 9 wolves and have studying their food sources and predation rates all summer. A crew of 5-7 individuals has searched hundreds of cluster locations documenting dozens of different predation events that are needed to meet Activity 1. Activity 1 is nearly complete for 2022, although we will repeat the effort for the next two summers as well.

Activity 2

This activity is not complete for 2022, but it is on schedule and we anticipate it being complete for for this year by the end of the month. The warm and dry weather at the end of summer means that leaf fall is delayed and flying to assess beaver caches and active lodges required an adjusted schedule. Annual fall beaver cache surveys will be completed using fixed-wing aircraft. Each active beaver lodge will be identified and mapped using real-time GIS software. Aerial beaver surveys will start this week and be used to estimate beaver population density and the location of all active beaver lodges in each wolf pack territory of interest. We have a very experienced pilot, Don Murray, who has worked for the National Park Service before both on Isle Royale National Park and Voyageurs National Park.

Activity 3

While we have made progress collecting data needed to evaluate the relationship between beaver abundance and wolf predation rates on moose and deer, the full analysis of this relationship will require multiple years of data. This activity is on track, progress is as expected, but it will not be complete until the end of the project.

Activity 4

We have made excellent progress delivering educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem. Our entire social media audience is >200K followers. We will present 6 professional talks and two posters at the International Wolf Symposium in October 2022. We have published 3 scientific papers related to the project this year. We have given 7 project related talks to audiences that include the University of Wisconsin, River Falls; Minnesota Pollution Control Agency; International Wolf Center; Rotary Clubs; and the Voyageurs Conservancy.

Dissemination

Please see Activity 4 Update, which details dissemination progress.

Status Update Reporting

Status Update April 1, 2022

Date Submitted: April 29, 2022

Date Approved: May 6, 2022

Overall Update

We made excellent progress towards achieving project Outcomes. This past year was the most successful monitoring effort to date in the Greater Voyageurs Ecosystem (GVE) in terms of the number of packs studied and the number of independent observations of each pack. In total, we estimated pack size for 14 packs and collected an average of 9.8 independent observations of the same pack size for each pack. During this period, we had 320 observations of 2 or more wolves traveling together. Multiple independent observations of the same pack size for each pack provides highly-reliable and accurate pack size estimates and ensures that pack size estimates are not based on 1 or 2 opportunistic, and potentially spurious, observations. We searched over 20,000 clusters from more than 40 wolves so far. This effort has revealed information on more than 1000 kills of various prey items. Preliminary findings indicate that on average during the summer, an adult wolf kills 13-15 deer fawns, 12-14 beavers, and lots of blue berries. In less than three years, our project has amassed a large following (>200, 000 people) on social media that continues to grow at a fast rate.

Activity 1

So far, for this project 105 wolves collared and 439,403 GPS-locations recorded from collared wolves. In 2021, eleven wolves were collared. Ongoing estimates of predation rate will be based on successfully searched 20,530 clusters of GPS-locations to identify and document 1,050 wolf-killed prey. Additionally, we have identified 327 den and rendezvous sites, counted and studied 134 wolf pups across 37 litters, deployed 225 remote cameras and captured thousands of photos and videos of wolves and other wildlife. We met milestone one for this reporting period and are making excellent progress towards completing this activity.

Activity 2

In October 2021 we were busy flying our annual aerial beaver survey. The goal of the annual survey is to identify and map all active beaver lodges in wolf pack territories because beavers are a big food source for wolves in the area. In the fall, beavers are preparing for winter by renovating their lodges with fresh mud and sticks, stockpiling trees and branches for food in their food caches next to their lodges, and re-enforcing their dams. All of this activity is typically quite obvious from the air. This year we surveyed a 1,780 square kilometer area (687 square miles). In total, we identified 1,672 active beaver lodges during the survey. But, this is just the raw survey data and we will have to spend some time pouring over the data to make sense of it. One particular challenge in our area is that some beaver families maintain 2 or more lodges in their pond. So while we identified 1,672 lodges this does not mean we identified 1,672 beaver families per se. We are making excellent progress towards completing this activity.

Activity 3

Ultimately, dense beaver populations either 1) buffer ungulate populations from wolf predation, thus decreasing wolf predation on ungulate populations; 2) negatively affect ungulate populations by facilitating a numerical response by wolves, thus increasing wolf predation on ungulates (i.e., apparent competition); or 3) do not influence wolf predation on ungulates. To understand the effect of beaver and ungulate densities on wolf densities we will use linear and non-linear modelling strategies. We still need to collect multiple years of data in order use simple linear regression to model the relationship between ungulate and wolf densities (wolf ~ ungulate), which is currently considered the best model explaining wolf densities. We are making excellent progress towards developing a model that will serve as a baseline to compare other models that incorporate the effects of beaver density, i.e. as a linear and non-linear predictors (predictor (wolf ~ beaver + ungulate).

Activity 4

Activity #4 for this project is to create educational material for outreach to the general public and promotion of Minnesota wildlife and the Greater Voyageurs Ecosystem. We made excellent progress, with the PI, postdoc, & project biologists will produce material such as captioned photos, videos, social media content, dynamic graphs, maps, illustrations, presentations, and press releases highlighting the natural history of Minnesota wildlife and the unique value of the Greater Voyageurs Ecosystem and Northwoods Minnesota.

Please see the Dissemination Update for further details.

Dissemination

Public Dissemination, Outreach, Education, and Engagement Summary:

- Have 184,379 followers across social media platforms
- 137,479 followers on Facebook
- 18,120 followers on Instagram
- 15,180 followers on Twitter
- 13,600 subscribers on Youtube
- Content has reached >107.6 million people via social media since November 2018 and is currently reaching 196,000 people per day.
- Number of people reached on social media is increasing exponentially
- Project has:
 - given 40 public presentations and 25 radio/TV interviews.
 - been featured in 4 national television shows (PBS Nature, Right This Minute, Rock the Park, PBS Market-to-Market)
 - written 10 articles for popular press and other partners)
 - been featured in 373 popular press articles, including in outlets such as the New York Times, National Geographic, Huffington Post, The Hill, The Times of London, and Science.
 - 373 articles in popular media.
- Secured research access to land from 127 landowners in Kabetogama and Ash River areas totaling >13,600 acres of private land access
- Contributed materials (photos, maps, videos, etc.) for a variety of miscellaneous projects