

**Environment and Natural Resources Trust Fund  
2020 Request for Proposals (RFP)**

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**Project Title:**

**ENRTF ID: 047-AH**

Do Beavers Buffer Against Droughts and Floods?

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**Category:** H. Proposals seeking \$200,000 or less in funding

**Sub-Category:** A. Foundational Natural Resource Data and Information

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**Total Project Budget: \$** 168,400

**Proposed Project Time Period for the Funding Requested:** June 30, 2023 (3 yrs)

**Summary:**

We propose to use existing data sets to link beaver population data to water storage in beaver ponds, to determine if they buffer against droughts and floods.

**Name:** Steve Windels

**Sponsoring Organization:** Voyageurs National Park

**Job Title:** Dr.

**Department:** Wildlife Resources Division

**Address:** 360 Hwy 11 E  
International Falls MN 56649

**Telephone Number:** (218) 283-6692

**Email** steve.windels@nps.gov

**Web Address:** www.nps.gov/voya

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**Location:**

**Region:** Northeast

**County Name:** Koochiching, St. Louis

**City / Township:**

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**Alternate Text for Visual:**

Left panel shows photo of beaver pond holding water during flood conditions; right panel shows photos depicting types of data collected by VNP.

<input type="checkbox"/>	Funding Priorities	<input type="checkbox"/>	Multiple Benefits	<input type="checkbox"/>	Outcomes	<input type="checkbox"/>	Knowledge Base	
<input type="checkbox"/>	Extent of Impact	<input type="checkbox"/>	Innovation	<input type="checkbox"/>	Scientific/Tech Basis	<input type="checkbox"/>	Urgency	
<input type="checkbox"/>	Capacity Readiness	<input type="checkbox"/>	Leverage	<input type="checkbox"/>		TOTAL	<input type="checkbox"/>	%



**PROJECT TITLE: Do Beavers Buffer Against Droughts and Floods?**

**I. PROJECT STATEMENT**

Beavers are called “ecosystem engineers” because their dam-building activities create ponds that store large amounts of water and sediment, altering the landscape on a scale rivaled only by humans in North America. Predicted climate change scenarios for Minnesota suggest changes in the timing and amounts of precipitation events will increase the frequency of both floods and droughts. Beaver ponds provide a natural solution to mitigate these effects because beaver ponds reduce the severity of flood events and store immense amounts of water during droughts. Due to this, beaver ponds will continue to be important habitat for fish and wildlife such as moose, deer, ducks, swans, and brook trout as Minnesota’s landscape and climate changes, proving beavers are indeed “keystone species.”

*The amount of water that beavers can store on the landscape is truly remarkable. Recent estimates for the 525 square-mile Greater Voyageurs Ecosystem suggest that beaver ponds could store more than 27 square-miles and 4.4 billion gallons of water in their ponds! If this was a lake, it would be in the Top Ten biggest lakes by area in Minnesota!*

Though techniques have been developed to calculate important metrics about how much water beavers can store in their ponds, we still lack an understanding of where, when, and why beavers build their ponds where they do. That is, we don’t know how changes in beaver populations, at the individual, colony, and population scales, affect where and when beavers build and maintain ponds. For example, how do beaver management actions such as dam removal or nuisance trapping alter the likelihood of beavers reoccupying a pond? How do fluctuations in beaver harvest totals affect beaver abundance and water storage capacity at larger spatial scales? Increased understanding of these processes will improve our understanding of how changes in beaver abundance will result in changes in water storage, which ultimately provides insight into how Minnesota’s Northwoods will respond to the increasing prevalence of floods and droughts in the future.

**Question 1: How much water storage exists in the Greater Voyageurs Ecosystem and has it changed through time?**

**Question 2: Why do beavers build dams and lodges where they do and how can understanding this assist management?**

**Question 3: How does death and dispersal of beavers affect creation of new dams or re-occupancy of old ones?**

The Greater Voyageurs Ecosystem (GVE) surrounding Voyageurs National Park contains some of the highest densities of beavers in the United States, and long-term research on beavers conducted in the park has yielded unprecedented insights into beaver ecology for the benefit of natural resource managers and scientists in Minnesota and all over the world. More than 60 peer-reviewed science publications have resulted from beaver-related research conducted at that park from the 1980s to the present. More importantly, park staff and collaborators have continued to collect a wealth of data from the beaver capital that is the GVE, in the process establishing one of the largest and longest running studies of beaver populations in the world. Park staff and cooperators, led by National Park Service Wildlife Biologist Dr. Steve Windels, have successfully live-trapped and marked more than **1,200** individual beavers, digitized more than **7,000** beaver ponds and dams, mapped nearly **4,000** beaver lodges in the park and surrounding landscape, and captured more than **150,000** photographs of beavers using game cameras since 2004.

This unprecedented data set has been compiled from a multitude of different projects with objectives distinct from the current proposal. We propose to extract new and valuable additional information that can be used **to improve science and management for the rest of Minnesota**. Specifically, we will address the following three questions using our data sets, and project results will have direct application to water resource issues anywhere in Minnesota where beavers can or do occur (which is most places!).

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1: How much water storage exists in the Greater Voyageurs Ecosystem and has it changed through time?**

Previous projects have digitized beaver ponds and dams on aerial photo sets spanning the period 1927-2013 within selected areas of the GVE. Additional work is planned for 2019 to include more recent photo sets. We will apply existing algorithms to convert pond dimensions (area, dam length, mean depth) to actual and potential water storage



**Environment and Natural Resources Trust Fund (ENRTF)  
2020 Main Proposal Template**

capacity to document changes over time and space, and how these relate to periods of flood and drought conditions. We will also link changes in water storage capacity to changes in beaver populations in the GVE.

**ENRTF BUDGET: \$40,800**

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Estimate water storage capacity for available years</i>	<i>June 2021</i>
2. <i>Final report and peer-reviewed publication submitted</i>	<i>December 2021</i>

**Activity 2: Determine factors affecting where beavers build dams and lodges to improvement management.**

Where beavers decide to build dams and lodges has an influence on the size and shape of individual beaver ponds, and thus affects their water storage capacity. Using our existing database of >4,000 beaver lodges, we will build computer models to understand what factors best predict where beavers build their dams and lodges.

**ENRTF BUDGET: \$50,800**

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Analyze factors affecting where beavers build dams and lodges</i>	<i>June 2022</i>
2. <i>Final report and peer-reviewed publication submitted</i>	<i>December 2022</i>

**Activity 3: How does death and dispersal of beavers affect creation of new dams or re-occupancy of old ones?**

We will use our existing data sets of live-capture data, lodge occupancy, and digitized pond layers to investigate how death and dispersal of individual beavers from a colony can affect occupancy or abandonment of dams and ponds used by colony members. We will also estimate population rates of mortality and dispersal to link to changes in pond formation rate and water storage capacity across the larger Greater Voyageurs Ecosystem.

**ENRTF BUDGET: \$76,800**

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Analyze factors affecting abandonment and establishment of beaver colonies</i>	<i>June 2022</i>
2. <i>Final report and peer-reviewed publication submitted</i>	<i>December 2022</i>

**III. PROJECT PARTNERS:**

Project lead Dr. Steve Windels has developed an international reputation as an expert in beaver and wetland ecology, resulting in 14 publications in peer-reviewed journals, 1 book chapter, 3 completed MS theses, and dozens of presentations at local and national conferences from beaver-related data collected at VNP.

**A. Partners receiving ENRTF funding**

- Dr. Steve Windels, Wildlife Biologist, Voyageurs National Park. Project Lead. Oversight of analysis and writing.

**B. Partners NOT receiving ENRTF funding**

- Dr. Joe Bump, Assoc. Professor, University of Minnesota. Assistance with study design and writing.
- Dr. Jake Ferguson. Asst. Professor, University of Hawaii. Assistance with study design, analysis, and writing.
- Sean Johnson-Bice, Research Assoc., University of Manitoba. Assistance with study design and writing.
- Tom Gable, PhD Student, University of Minnesota. Assistance with study design and writing.

**IV. LONG-TERM- IMPLEMENTATION AND FUNDING:**

This project builds on an existing long-term database of beaver data unparalleled in North America, conservatively representing >\$2,000,000 in previous funding. This project also builds on the 2017 LCCMR project “Effects of Wolves on Beavers, Moose, and Deer in the Border Lakes Region.” We will disseminate our information through peer-reviewed publications and reports, print/social media, and public presentations to ensure knowledge transfer.

**V. TIME LINE REQUIREMENTS:**

This project utilizes several existing databases of information about beaver populations. No field work for new data collection is planned after July 1, 2020. Once funding is transferred to the NPS and staff are hired by the end of 2020, we believe the project will progress rapidly and can be completed in the proposed 2.5-year time window.

**Attachment A: Project Budget Spreadsheet**  
**Environment and Natural Resources Trust Fund**  
**M.L. 2020 Budget Spreadsheet**



**Legal Citation:**  
**Project Manager:** Steve Windels  
**Project Title:** Do Beavers Buffer Against Droughts and Floods?  
**Organization:** Voyageurs National Park  
**Project Budget:** \$168,400  
**Project Length and Completion Date:** 2.5 years; December, 2022  
**Today's Date:** April 13, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Budget	Amount Spent	Balance	
<b>BUDGET ITEM</b>					
<b>Personnel (Wages and Benefits)</b>		\$ 160,000	\$ -	\$ 160,000	
Term Wildlife Biologist (66% salary, 33% benefits); 100% for 2 years; will implement analysis and serve as lead author for publications and reports.					
<b>Equipment/Tools/Supplies</b>					
Computer software, licensing, office supplies		\$ 3,000	\$ -	\$ 3,000	
<b>Travel expenses in Minnesota</b>					
In-state travel for 2 meetings/yr with project partners and 1 presentation/yr at in-state science conference to present results (mileage, food, lodging)		\$ 3,000	\$ -	\$ 3,000	
<b>Other</b>					
Page charges for peer-reviewed publications (3@ \$800/ea)		\$ 2,400	\$ -	\$ 2,400	
<b>COLUMN TOTAL</b>		\$ 168,400	\$ -	\$ 168,400	
<b>SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT</b>					
	<b>Status (secured or pending)</b>	<b>Budget</b>	<b>Spent</b>	<b>Balance</b>	
<b>Non-State:</b>		\$ -	\$ -	\$ -	
<b>State:</b>		\$ -	\$ -	\$ -	
<b>In kind:</b>					
Voyageurs National Park: Wildlife Biologist - 20% FTE salary/benefits for 2.5 yrs for project management, analysis, and writing (\$61,000); GIS Specialist 10% FTE salary/benefits for 2.5 yrs GIS support (\$24,000); use of office space, computers, software, etc. (\$5,000); Seasonal technician - 25% FTE salary/benefits for 2.0 years for data entry and management (\$20,000). Estimated investment in the trapping, aerial survey data sets, and air photo mapping by the NPS and other partners is >\$2,000,000.		Pending	\$ 110,000	\$ -	\$ 110,000
<b>Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS</b>					
	<b>Amount legally obligated but not yet spent</b>	<b>Budget</b>	<b>Spent</b>	<b>Balance</b>	
<b>Past and Current ENRTF Appropriation:</b> M.L. 2017, Chp. 96, Sec. 2, Subd. 03l; Effects of Wolf Predation on Beaver, Moose, and Deer; \$293,000. The majority of funds for this project are for study of wolf predation behavior. \$150,000 has been obligated but not spent to a university partner. Most remaining unspent funds are for purchase of wolf telemetry collars, collar data acquisition, and other field costs. Up to \$5,000 of the remaining unspent funds from this project could go towards aerial beaver lodge surveys in 2019, and this data will be used in Activities 1-3 for this proposal "Do Beavers Buffer Against Droughts and Floods."		\$ 150,000	\$ 293,000	\$ 36,119	\$ 256,881



# Do Beavers Buffer Against Droughts and Floods?




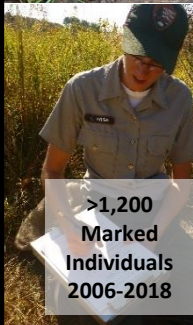

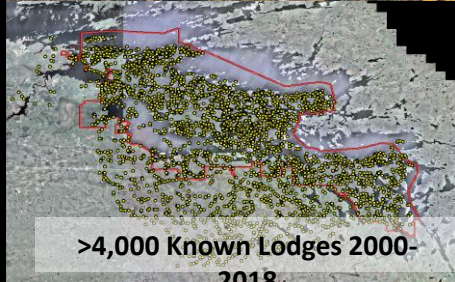
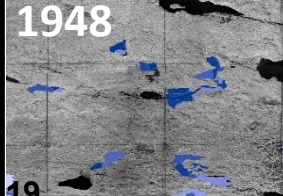
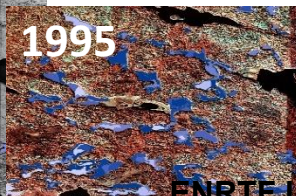
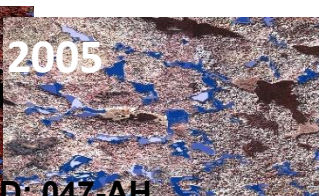
We will use an unprecedented, long-term database to link beaver population data to landscape water storage to determine how beavers can be managed to buffer against droughts and floods.



## Project Outcomes

- Estimates of water storage capacity in beaver ponds over time.
- Link beaver population dynamics to changes in water storage capacity.
- Improved beaver management to meet local and regional planning needs.

Voyageurs National Park will use data on beaver populations collected from 2000-2018, the longest and largest continuous beaver research program in North America, to address these questions.

Live-Trapping		Aerial Lodge Surveys
		
		
<p>&gt;1,200 Marked Individuals 2006-2018</p>		<p>&gt;4,000 Known Lodges 2000- 2018</p>
Beaver Pond Mapping Through Time		
		
<p>1948      1995      2005</p> <p>&gt;7,000 Known Ponds and Dams</p>		

## Project Title: Use Existing Data on Beaver Populations to Improve Management Outcomes in Minnesota

### 2020 LCCMR Project Manager Qualifications and Organization Description

#### I. QUALIFICATIONS

Dr. Steve K. Windels has been a Research Wildlife Biologist at Voyageurs National Park, MN from 2003-present. He currently oversees research and monitoring projects on beavers, wolves, moose, and other wildlife species. Most relevant to the proposed project, he and his staff have successfully live-trapped and marked more than 1,200 individual beavers, mapped nearly 4,000 beaver lodges in the park and surrounding landscape, and captured more than 150,000 photographs of beavers using game cameras since 2004. He won the prestigious National Park Service Director's Award for Natural Resource Research in 2014. He is Adjunct Assistant Professor in the Department of Fisheries, Wildlife, and Conservation Biology at the University of Minnesota.

#### Education/Certification

Ph.D. in Wildlife Ecology, Michigan Technological University  
M.S. in Range and Wildlife Management, Texas A&M University – Kingsville  
B.S. in Fisheries and Wildlife Management, University of Minnesota  
Certified Wildlife Biologist® by The Wildlife Society.

#### Relevant Publications

- Johnson-Bice, S., K. Renik, **S.K. Windels**, and A. Hafs. 2018. A review of beaver-salmonid relationships and history of management actions in the Western Great Lakes (U.S.) Region. *North American Journal of Fisheries Management*. DOI: 10.1002/nafm.10223
- Gable, T.D., T. Stanger, J.K. Bump, and **S.K. Windels**. 2018. Do wolves ambush beavers? Video evidence for higher-order hunting strategies. *Ecosphere* 9(3):e02159. doi 10.1002/ecs2.2159
- Gable, T.D., **S.K. Windels**, F. Rosell, and M. Romanski. 2018. The forgotten prey of an iconic predator: a review of gray wolf-beaver dynamics. *Mammal Review* 48:123-138.
- Windels, S.K.** 2017. Beavers as Engineers of Wildlife Habitat. *In* *Beavers: Boreal Ecosystem Engineers*. Carol Johnston, ed. Springer-Verlag Press.
- Gable, T.D., and **S.K. Windels**. 2017. Kill rates and predation rates of wolves on beavers. *Journal of Wildlife Management*. DOI 10.1002/jwmg.21387.
- Gable, T.D., **S.K. Windels**, J.G. Bruggink, and A.T. Homkes. 2016. Where and how wolves kill beavers. *PLoS One* 11(12).
- Smith, J.B., **S.K. Windels**, T. Wolf, R. Klaver, and J.L. Belant. 2016. Do transmitters affect fitness indices of American beavers (*Castor canadensis*)? *Wildlife Biology* 22:117-123.
- Windels, S.K.**, and J.L. Belant. 2016. Performance of tail-mounted transmitters on American beavers *Castor canadensis* in a northern climate. *Wildlife Biology* 22:124-129.
- Johnston, C.L., and **S.K. Windels**. 2015. Using beaver works to estimate colony activity in boreal landscapes. *Journal of Wildlife Management* 79:1072-1080.
- Severud, W.J., J.L. Belant, **S.K. Windels**, and J.G. Bruggink. 2013. Seasonal variation in assimilated diets of American beavers. *American Midland Naturalist* 169:30-42.
- Severud, W.J., **S.K. Windels**, J.L. Belant, and J.G. Bruggink. 2013. The role of forage availability on diet choice and body condition in American beavers (*Castor canadensis*). *Mammalian Biology* 78: 87-93.
- Windels, S.K.** 2013. Ear tag loss rates in American beavers. *Wildlife Society Bulletin* 38:122-126.
- Severud, W.J., J.L. Belant, J.G. Bruggink, and **S.K. Windels**. 2011. Predator cues reduce American beaver use of foraging trails. *Human Wildlife Interactions* 5:296-305.

#### II. RESPONSIBILITIES

Dr. Windels will coordinate and manage the overall project, and directly supervise the term NPS biologist, who will implement the data analysis plan and be the primary author of peer-reviewed publications. Dr. Windels will also oversee all aspects of study design, analysis, and final reporting.

#### III. ORGANIZATION DESCRIPTION

The mission of the National Park Service, celebrating its 100<sup>th</sup> Anniversary in 2016, is “to preserve unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations.” Voyageurs National Park, Minnesota’s only National Park, was established in 1975 to preserve the history and natural resources of the Border Lakes Region. In many ways, beavers are to Voyageurs National Park as wolves are to Yellowstone National Park, or wildebeest are to the Serengeti. They are an iconic wildlife species whose activity shapes both the ecological foundations of the park but also the experience of we humans who visit it. Voyageurs National Park presents a unique window into the past about the dramatic importance of beavers to shaping their environment, perhaps only on a scale equaled by humans. The National Park Service has a strong mission to promote the use of National Parks as natural laboratories to better understand the natural world.