**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 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**

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| **Outcome** | **Completion Date** |
| *1. Estimate water storage capacity for available years* | *June 2021* |
| *2. Final report and peer-reviewed publication submitted* | *December 2021* |

**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**

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| **Outcome** | **Completion Date** |
| *1. Analyze factors affecting where beavers build dams and lodges* | *June 2022* |
| *2. Final report and peer-reviewed publication submitted* | *December 2022* |

**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**

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| **Outcome** | **Completion Date** |
| *1. Analyze factors affecting abandonment and establishment of beaver colonies* | *June 2022* |
| *2. Final report and peer-reviewed publication submitted* | *December 2022* |

**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.