2016 Project Abstract
For the Period Ending June 30, 2019

PROJECT TITLE: Restoration of Elk to Northeastern Minnesota
PROJECT MANAGER: James D. Forester
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2016, Chp. 186, Sec. 2, Subd. 03l

APPROPRIATION AMOUNT: $300,000
AMOUNT SPENT: $300,000
AMOUNT REMAINING: $ 300,000

Sound bite of Project Outcomes and Results
This study examined the feasibility of restoring elk to northeastern Minnesota. It provides information for determining where elk restoration will be successful, should it occur. Results show that habitat suitability and landowner support are not limiting factors for restoring elk to northeastern Minnesota.

Overall Project Outcome and Results
Elk historically occupied most of Minnesota prior to the early 1900s, but now only 3 small groups occur in northwestern Minnesota. These groups are managed at low levels to reduce human-elk conflict. Forested areas of the state could avoid some conflict and see ecological and economic benefits from returning elk to the landscape. Evidence from other states indicates elk restoration can be successful, but success is dependent on forest management and public support for elk by local communities. This study examined the feasibility of restoring elk to 3 study areas in northeastern Minnesota. It provides information that will be useful for determining where elk restoration will be successful, should it occur, including information about social acceptance and habitat suitability. It resulted in 2 reports (McCann et al. 2019 and Walberg et al. 2019).

To assess landowner and local resident attitudes toward restoring elk to northeastern Minnesota, we surveyed 4,500 private landowners and 4,000 local residents. Eighty percent of landowners and 81% of local residents within the study areas strongly supported restoring elk to northeastern Minnesota. Landowner support for restoration was highest on the Cloquet Valley study area and lowest on the Fond du Lac study area. Local resident support was highest in southern St. Louis County, followed by Duluth, northern Pine County, and Carlton County.

To evaluate elk habitat suitability and to provide additional assessment of social support for restoring elk to northeastern Minnesota, we measured elk forage in the field and utilized GIS data to map habitat and social suitability. Our results show that habitat suitability and landowner support are not limiting factors for restoring elk to northeastern Minnesota. We sampled 186 field plots and found that mean summer forage at field plots exceeded amounts elk prefer and winter forage matched amounts where elk occur in Wisconsin. Estimates of how many elk are likely to be supported (5 to 8 elk/6 mi2) were similar to elk densities in Wisconsin and Michigan. Estimates of biological carrying capacity ranged from 287 on the Fond du Lac study area to 551 elk on the Cloquet Valley study area. Each of the 3 study areas: (1) had large amounts of habitat with suitability scores similar to where elk occur in Wisconsin; (2) a majority of land in public ownership; and (3) and relatively low human-elk conflict risk. Considering factors we assessed to be equally important did not result in statistically different study area rankings (on average, all 3 study areas were about the same) but some study areas ranked better than others when we weighted factors (considered some factor to be more important than others).

Project Results Use and Dissemination

Schrage delivered 16 presentations about this project to multiple groups, including: Rocky Mountain Elk Foundation banquets in Duluth and Prior Lake, the Minnesota Sharp-tailed Grouse Society in Hinckley, the Winton Historical Society, staff from the MNDNR's Northwest Region, the Minnesota Soil and Water Conservation District Forestry Association, the Breckinridge Chapter of the Izaak Walton League, Rocky Mountain Elk Foundation members in the Twin Cities, the Moose Lake Covenant Church Outdoor Expo, the annual meeting of the Minnesota Division of the Izaak Walton League, the Minnesota Forest Resources Partnership, St. Louis County Leaseholders, Northwoods Audubon, MNDNR Region 2 Assistant Wildlife Managers, a joint meeting of Minnesota Forest Industries and MNDNR Forestry, and at a meeting of the St. Louis County Committee of the Whole. McCann and PhD student Eric Walberg delivered presentations about the project at the joint meeting of the State Chapters of The Wildlife Society and Society of American Foresters in Duluth, MN. Fulton and McCann delivered presentations about the project at the Western Association of Fish and Wildlife Agencies' Biennial Deer & Elk Workshop in Marfa, TX. This project was featured in the Duluth News Tribune, Pioneer Press, Brainerd Dispatch, the Minnesota Deer Hunters Association publication of "Whitetales", and Outdoor News. Educational displays about elk and this project were set up and staffed by tribal, Rocky Mountain Elk Foundation, University of Minnesota, and volunteer staff at the Carlton County and Minnesota State Fairs. Additionally, Schrage and other tribal personnel staffed booths that highlighted this project at the Minnesota State Fair and a second at the Cloquet Forestry Center's 50th anniversary celebration of their Conservation Education Day event, and Schrage and McCann ran an informational booth for the project at the Outdoor News Deer and Turkey Classic show. We held multiple project meetings that included MNDNR staff. We developed an internet presence, including a website (http://elk.umn.edu) and Facebook page (https://www.facebook.com/NE.MN.elk).

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2016 Work Plan Final Report

Date of Report: 16 August 2019

Final Report

Date of Work Plan Approval: June 7, 2016

Project Completion Date: 30 June 2019

PROJECT TITLE: Restoration of Elk to Northeastern Minnesota

Project Manager: James D Forester

Organization: University of Minnesota

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Location: Carlton, Pine, and St. Louis Counties

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$300,000**
	Amount Spent:	**$300,000**
	Balance:	**$0**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 03l

Appropriation Language:
$300,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota in cooperation with the Fond du Lac Band and Rocky Mountain Elk Foundation to determine the habitat suitability and levels of public support for restoring elk to northeastern Minnesota. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Restoration of Elk to Northeastern Minnesota

II. PROJECT STATEMENT:

Elk historically occupied most of Minnesota prior to the early 1900's. Although two small populations were re-established in northwest MN, they are currently managed at low levels to reduce human-wildlife conflict. Forested areas of the state, however, could avoid some of these conflicts and see significant ecological and economic benefits from returning elk to the landscape. Re-establishing this keystone herbivore will help restore the state's traditional wildlife heritage, diversify the large mammal community, increase tourism from wildlife viewers, and eventually provide additional hunting opportunities. Finally, a landscape actively managed for elk will benefit other species adapted to young forests and brushlands. Evidence from other eastern states indicates elk restoration can be successful, but success is dependent on active forest management and public support for elk by local communities.

This research will determine areas of suitable habitat and levels of public support for restoring elk to Northeastern Minnesota. Research will be conducted in an area already identified as having local public interest and abundant public forest land (i.e., southern St Louis, Carlton, and northern Pine counties; Figure 1). The research team will build upon existing eastern elk restoration research to address two research goals:

1) Identify the amount of public support for a restored elk population by surveying citizens in and around the prospective restoration sites.

2) Determine where suitable habitat exists and how many elk it could sustain. Combine the public support and habitat suitability maps to identify areas likely to support a restored elk population.

Despite potential economic and ecological benefits, care must be taken to determine if suitable habitat exists for elk and if the public will support having elk on the landscape. Our initial interaction with county governments and conservation groups indicates there is great interest in exploring elk restoration; however, we will conduct a quantitative survey of public attitudes to determine levels of tolerance for elk across the study area. To identify locations of suitable habitat, we will compile existing data on land use and land cover and collect field data on forage availability. We will use these data in conjunction with a synthesis of existing elk research in the Midwest to map how habitat suitability varies across the study area. Finally, we will combine the public support and habitat suitability maps to identify areas most likely to support a successful restoration. This study will provide critical information to wildlife managers and local governments allowing them to make an informed decision regarding habitat suitability and public support for the next steps in elk restoration.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of 2 December 2016:

We are well into the initial planning stages of this project. We have met as a group to lay the initial ground work for the survey effort and have hired a graduate student to work on the survey portion of this project; a postdoctoral job advertisement is currently being drafted. The first major decisions for this project are to identify where the most suitable restoration locations are. Key to this is determining the minimum area that should be considered, and what ecological characteristics the area should include. Because Wisconsin used a core elk range of 288 mi^2 for their Clam Lake herd and 320 mi^2 for the Black River herd, we are initially looking for areas within the larger region of southern St. Louis, Carlton and northern Pine Counties that are >300 mi^2 to focus our analysis on. Based on the general habitat requirements of elk, the focal areas should include a large core of public land, and should represent a mosaic of brushland and forests. We are working with local area DNR wildlife staff and county and tribal land managers to identify candidate focal areas. Once this is complete, we will fine-tune our survey effort to target the general public across the study area as well as land owners in and around the identified focal areas. We have begun collecting relevant GIS land-cover and land-use maps to guide

our efforts and have started the development of a simulation model that will help us estimate how restored elk are likely to use each of the landscapes.

Project Status as of 30 June 2017:
Both activities are now well underway. We worked with State and County land managers to identify three study areas that are centered on large tracts of public land and have begun to survey these areas to assess the availability of potential elk forage and cover. Across the region we have conducted two focus group sessions with local landowners and are using this interaction to refine the survey questions. A draft survey instrument has been developed and is being refined with input from University of Minnesota, Fond du Lac, and MN DNR study team members; the survey will be deployed later this summer. We have also developed a web presence with a Facebook page (https://www.facebook.com/NE.MN.elk) and website (http://elk.umn.edu).

Project Status as of 31 January 2018:
Progress continues for both research activities. Following input from University of Minnesota researchers, Fond du Lac wildlife resource management staff, and Minnesota DNR staff, we have nearly finalized the landowner and resident surveys (activity 1); the surveys will be sent out in early February 2018 using a sampling design that was completed in late 2017. Habitat sampling (Activity 2) was completed at 112 locations on our 3 ecological study areas (centered on Cloquet Valley, Fond du Lac, and Nemadji State Forests), and preliminary analyses were conducted. Planning is underway for additional habitat sampling that is to take place within the 3 ecological study areas during summer 2018.

We held 3 project meetings with staff from the DNR that included discussion of study design for Activities 1 and 2, and preliminary results for Activity 2. Dissemination included multiple presentations to DNR staff and the public, including displays at the Carlton County and Minnesota State Fairs. Media coverage included articles featured in multiple outlets, including the Duluth News Tribune and the Minnesota Deer Hunters Association publication of “Whitetales”.

Project Status as of 30 June 2018:
A resident survey and a landowner survey (Activity 1) were finalized and sent out in February. Three rounds of follow-up surveys were then sent out to residents and landowners that did not respond to the initial surveys. To date, return rates for the resident survey and landowner survey are 42.9% and 58.5%.

Eighty-six landowners were contacted, and access was granted for vegetation sampling on 76 parcels of private land (activity 2). A method for sampling vegetation on private lands and rights-of-way was also devised. A four-person field-crew was hired and trained, and has begun data collection.

We held one project meeting that included discussion of preliminary results for Activity 1 and study design for Season 2 of Activity 2. Schrage and McCann ran an informational booth for the project at the Outdoor News Deer and Turkey Classic show, and Schrage gave a presentation at the annual meeting of the Minnesota Division of the Izaak Walton League. Additional outreach and dissemination efforts continue through a website and a Facebook page.

Amendment Request (Amendment Approved by LCCMR 2/26/2019):

We need to retroactively move $925 from “Equipment/Tools/Supplies” to “Service Contracts” because the postage costs were included in the mailing services fees (i.e., we did not buy stamps separately).

Due to cost savings on travel and equipment, and would like to move the balances ($1,154 from equipment; $1,649 from travel) to Personnel to cover increases in costs in graduate student salary and fringe.

Project Status as of 31 January 2019:
Data entry from surveys of landowners and the general public has been completed and success rates have been quantified. The general public survey had a 45.8% response rate and the landowner survey had a 59.6% response rate. We completed habitat sampling, which resulted in a total of 217 sampling locations across the two summers that we sampled. Data were validated and organized, and preliminary habitat analysis were completed. Analysis of survey and habitat data is ongoing, and we are developing methods for combining results from Activity 1 to those from Activity 2 to develop a suitability map that incorporates public perceptions and habitat requirements. Schrage gave multiple presentations on elk restoration, staffed two booths that highlighted this project, and attended a one-day elk workshop in Wisconsin. Outreach and dissemination efforts continue through a website and a Facebook page with a number of followers that has grown to 198.

Overall Project Outcomes and Results:
Elk historically occupied most of Minnesota prior to the early 1900s, but now only three small groups occur in northwestern Minnesota. These groups are managed at low levels to reduce human-elk conflict. Forested areas of the state could avoid some conflict and see ecological and economic benefits from returning elk to the landscape. Evidence from other states indicates elk restoration can be successful, but success is dependent on forest management and public support for elk by local communities. This study examined the feasibility of restoring elk to three study areas in northeastern Minnesota. It provides information that will be useful for determining where elk restoration will be successful, should it occur, including information about social acceptance and habitat suitability. It resulted in two reports (McCann et al. 2019 and Walberg et al. 2019).

To assess landowner and local resident attitudes toward restoring elk to northeastern Minnesota, we surveyed 4,500 private landowners and 4,000 local residents. Eighty percent of landowners and 81% of local residents within the study areas strongly supported restoring elk to northeastern Minnesota. Landowner support for restoration was highest on the Cloquet Valley study area and lowest on the Fond du Lac study area. Local resident support was highest in southern St. Louis County, followed by Duluth, northern Pine County, and Carlton County.

To evaluate elk habitat suitability and to provide additional assessment of social support for restoring elk to northeastern Minnesota, we measured elk forage in the field and utilized GIS data to map habitat and social suitability. Our results show that habitat suitability and landowner support are not limiting factors for restoring elk to northeastern Minnesota. We sampled 186 field plots and found that average summer forage at field plots exceeded amounts elk prefer and winter forage matched amounts where elk occur in Wisconsin. Estimates of how many elk are likely to be supported (5 to 8 elk/6 mi^2) were similar to elk densities in Wisconsin and Michigan. Estimates of biological carrying capacity ranged from 287 on the Fond du Lac study area to 551 elk on the Cloquet Valley study area. Each of the 3 study areas: (1) had large amounts of habitat with suitability scores similar to where elk occur in Wisconsin; (2) a majority of land in public ownership; and (3) and relatively low human-elk conflict risk. Considering factors we assessed to be equally important did not result in statistically different study area rankings (on average, all 3 study areas were about the same) but some study areas ranked better than others when we weighted factors (considered some factor to be more important than others).

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Assessing public attitudes towards elk restoration.
Description: Understanding the public's attitudes and acceptance of elk and their potential impacts are key components of assessing the viability of elk restoration. Long-term management of elk will require an adaptive impact approach in which management objectives and strategies are guided by the preferences of the impacted public. To address this need, we propose conducting surveys and workshops with local citizens.

Three important groups include: private landowners in the potential restoration zone, hunters and the larger conservation community, and the general public residing in or near the potential restoration zone. The

completed target sample size for each study group will provide error estimates within 4%. We will contact potential respondents in each target population using current best practices for multi-modal survey contact designs and probability-based sampling approaches. Probability-based samples are essential to allowing generalization of results back to the populations of interest. Initial contacts will be made using address-based sampling designs and mailed paper surveys. Subsequent contacts will be made via e-mail when possible with provision of a web-based response.

We will use county property records to identify and randomly select landowners for inclusion in the study and augment county contact information with available e-mail addresses to allow for direct electronic contact of respondents with e-mail addresses. We will use Address Based Sampling (ABS) utilizing the US Postal Service's Computerized Delivery Sequence File (or 9-1-1 response) addresses to randomly select individual households for participation in the study. This ABS approach provides 100% coverage of owner-occupied and rental residential addresses and will be augmented with e-mail contact information so that follow-up contacts can be electronic and data collection web-based. We will use the Minnesota Department of Natural Resource's Electronic License System data to randomly select hunters and other conservationists for participation in the study. Up to 30% of individuals in the ELS provide an e-mail contact, and we will append additional e-mail addresses using commercially available services so that an e-mail contact and web-based survey option can be provided to those respondents who prefer electronic contact. This probability-based sampling and multi-modal administration strategy will help to minimize sampling, non-coverage and response biases.

The primary objectives of the surveys will be to understand citizens': 1) attitudes toward elk and elk restoration; 2) acceptance and tolerance of potential elk impacts; 3) preference for management objectives concerning elk restoration including elk population size and geographical distribution; and 4) preferences for management strategies to address potential conflicts with elk. Our approach for gathering social survey data will be guided by numerous studies assessing the social aspects of wildlife restoration. Based on our findings, we will develop a spatially explicit map of expected tolerance levels for a restored elk population.

We will also conduct a minimum of 6 local workshops and webinars after the social survey data have been collected and analyzed so we can better understand the public perceptions of the social survey data and ecological research from Activity 2 and facilitate discussion among the attendees about the research findings. The primary objectives of the workshops are to disseminate research findings and facilitate dialogue concerning the implications of the findings. We will also develop a website and use traditional and social media outlets to distribute information about the project to the public.

Summary Budget Information for Activity 1:

ENRTF Budget: $141,607
Amount Spent: $141,607
Balance: $ 0

Outcome	Completion Date
1. *Design, implement and analyze data for 3 survey groups (based on up to 12,182 mailed surveys; this is the most effective method for a statistically valid survey).*	December 2017
2. Complete social acceptance map for the study area.	May 2018
3. *Complete 6 public workshops / webinars (25-50 attendees expected at each).*	May 2019
4. *Develop website and use traditional and social media outlets to distribute information and receive comments about the social and ecological survey results.*	June 2019

Activity Status as of 2 December 2016:
We have conducted an initial planning meeting that included representatives from the MN DNR and have identified a graduate student, Eric Walberg, to work on this project. Eric is already involved with the survey on

the NW elk population, and has begun developing a survey to deploy in this study area. We are currently deciding on the appropriate survey questions to ask and how best to identify the different target groups.

Activity Status as of 30 June 2017:
During the past 6 months we have conducted three project design meetings that included participation from University of Minnesota researchers, Fond du Lac wildlife resource management staff, and Minnesota DNR researchers and managers. We have refined the study areas, target study population for the surveys, and sampling protocols. A draft survey instrument has been developed and is being refined with input from University of Minnesota, Fond du Lac, and MN DNR study team members. To assist with survey design and pretesting, focus groups were conducted in early June with landowners in northeast Minnesota. The focus groups provided a productive discussion with local landowners that helped develop the survey and more effectively identify the benefits and/or concerns local residents and landowners might have about restoring a local elk population.

Our outreach and dissemination efforts have included creating a website and Facebook page, along with scheduling focus groups of landowners in northeast Minnesota. The website was created to provide information about elk in Minnesota and restoration efforts in the eastern United States, along with providing summaries of the research projects to be conducted. The Facebook page was created to provide instantaneous communication with interested citizens with relevant updates about the research projects.

Activity Status as of 31 January 2018:
In late 2017 and early 2018 we worked toward finalizing the questions and sampling designs for landowner and local resident questionnaires using input from University of Minnesota researchers, Fond du Lac wildlife resource management staff, and DNR study team members. Questions were informed by focus group meetings with landowners in northeastern Minnesota that we held in June 2017. Questionnaire topics include, (1) landowner property characteristics, (2) knowledge about elk, (3) attitudes about elk restoration, (4) elk restoration objective prioritization, (5) risk perceptions of restoring elk, (6) comparative impacts of deer and elk, (7) value of restoring elk, (8) trust in elk managers, (9) elk-related recreation, (10) outdoor activities and organization membership, and (11) demographic characteristics. In early February we will send questionnaires to 4,500 landowners and an additional 4,000 local residents in northeastern Minnesota. We will survey landowners using parcel ownership information obtained from county tax records. We will survey local residents after obtaining contact information for households obtained from a third-party vendor.

Activity Status as of 30 June 2018:
Starting in early February, we contacted 4,500 landowners and 4,000 local residents in northeastern Minnesota to complete a survey questionnaire about the potential for elk restoration. We randomly sample landowners with three study areas using parcel ownership information obtained from county tax records as the sampling frame. We have contacted a stratified random sample of local residents within four study areas using contact information for households obtained from a third-party vendor. The three study areas for the landowner survey include: (1) Cloquet Valley State Forest in St. Louis County, (2) Fond du Lac Indian reservation in St. Louis and Carlton Counties, and (3) Nemadji State Forest in Pine County. The four study areas for the survey of local residents include: (1) St. Louis County south of the St. Louis River, (2) Carlton County, (3) Pine County north of Minnesota Highway 48, and (4) Duluth and the surrounding suburbs.

We have contacted landowners and the general public four times to complete a survey questionnaire. We are continuing to receive survey responses and data entry is ongoing. Of the 4,000 recipients of the general public survey, we have had 1,496 responses and 509 invalid contacts (bad addresses, deceased individuals, etc.) resulting in a 42.9% response rate. Of the 4,500 recipients of the landowner survey, we have had 2,514 responses and 204 invalid contacts resulting in a 58.5% response rate.

Activity Status as of 31 January 2019:

Data entry from surveys of landowners and the general public have been completed. Of the 4,000 recipients of the general public survey, we received 1,574 responses and 566 invalid contacts (bad addresses, deceased individuals, etc.) resulting in a 45.8% response rate. Of the 4,500 recipients of the landowner survey, we received 2,550 responses and 222 invalid contacts resulting in a 59.6% response rate. We are currently analyzing the data and writing a draft report. We have also prepared data for combining results from Activity 1 to those from Activity 2 in order to develop a suitability map that incorporates both public perceptions and habitat requirements.

Final Report Summary:
We surveyed 4,500 private landowners and 4,000 local residents in northeastern Minnesota to describe landowner and local resident attitudes toward potentially restoring an elk population to northeastern Minnesota. Eighty percent of landowners and 81% of local residents within the study areas strongly supported restoring elk to northeastern Minnesota. Landowner support for restoration in northeastern Minnesota was highest on the Cloquet Valley study area and lowest on the Fond du Lac study area, and a majority of landowners (76%) were supportive of restoring elk within five miles of their property. Local resident support was highest in southern St. Louis County, followed by Duluth, northern Pine County, and Carlton County.

Hunters were more supportive of restoring elk than non-hunters and this was true for landowners (81% vs 75%) and local residents (80% vs 75%). Among landowners, non-farmers were more supportive of restoring elk than were farmers (82% vs 73%) and timber producing landowners were less supportive of restoring elk than were non-producers (76% vs 81%). Respondents believed that the most likely outcomes from restoring an elk population were providing opportunities to view elk, restoring a native wildlife species, and providing opportunities to hunt elk. The least likely outcomes were believed to be negative impacts on other wildlife, increased risk of disease transmission to livestock and wildlife, and damage to trees and forest vegetation.

The most important management objectives for landowners were: (1) minimizing impacts to existing wildlife, (2) restoration of a native species, and (3) minimizing impacts to deer populations and deer hunting. The most important management objectives for local residents were: (1) minimizing impacts to existing wildlife populations, (2) restoration of a native species, and (3) maximizing sustainable elk population size.

Landowners and local residents believed that there would potentially be moderate to high potential benefits from restoring elk, and that restoring elk would pose little to moderate threat to the economic well-being (e.g., agriculture, personal property) and health/safety (vehicle collisions) of the respondents and other individuals in the local community. Respondents perceived that having elk within the study areas would pose moderate threat to other wildlife in the area (disease) and to trees and forest vegetation.

Landowners and local residents had moderate knowledge of elk in Minnesota, with hunters having moderate knowledge and non-hunters having low knowledge. A majority of landowners and local residents agreed with these statements: (1) “it is important that Minnesota someday have an abundant elk population within the study areas” (64% of landowners and 69% of local residents); “whether or not I would get to see an elk, it is important to me that they could exist within the study areas” (70% of landowners and 76% of local residents); and “it is important to establish elk populations within the study areas so future generations can enjoy them” (73% of landowners and 79% of local residents). A majority of landowners (61%) and local residents (64%) indicated that they would likely make a trip to view, photograph or hear elk within the study areas in Minnesota. About one-quarter of landowners (24%) and but fewer than 1 in 5 local residents (16%) indicated that they plan to apply for a Minnesota elk hunting license in the future. In general, landowners were more likely than local residents to have applied for or have drawn an elk license or apply for one in the future.

ACTIVITY 2: Ecological aspects of elk restoration
Description:

Whether a restored elk population will thrive at a given site will depend on a variety of factors. Here, we will focus our efforts on determining: 1) human land-use patterns; 2) the distribution of current land-cover types (including forest age structures and the specific agricultural uses); 3) expected future changes to land cover; 4) the diversity and abundance of forage within each cover type; and 5) locations of captive cervid operations. We will consider risk of agricultural damage and other potential human conflicts as well as expected elk movement patterns and population growth. Finally, we will use the existing 2013-2014 MN land-cover dataset to identify prospective sites; field surveys of forage availability will be conducted in all of these areas to estimate the distribution of food resources (both quality and amount) within each land-cover type. We will combine these data with existing information on elk habitat use to develop a habitat suitability map and estimate the carrying capacity of potential relocation sites. This map will be integrated with the final product of Activity 1 to produce an elk suitability map for the region.

Compilation of existing spatial data: In Year 1, we will collect existing data about recent land use (e.g., locations of agriculture, timber harvest, and captive cervid operations) and land cover from state and county agencies. Future use of public lands will be considered by discussing forest management plans with agency representatives; when possible (i.e., where spatially explicit plans of timber harvest are available) we will include expected land-cover change into our projections of suitability. Land cover will be validated in Years 2 and 3 by visiting 250 sites across the study area.

Forage availability: We will identify 120 sites distributed among the primary land-cover types within the study area. During the summer of Year 2 (June-August) we will visit each site to estimate plant species abundance and biomass for all functional groups (herbaceous plants, grasses, and low woody vegetation). For a subset of the sites we will collect and dry plant biomass to refine biomass allometric equations for the study area. The forage diversity and abundance estimates will be extrapolated across the study area, and these maps crossvalidated and then ground-truthed by visiting 50 sites in the summer of Year 3.

Restoration Suitability: We will synthesize current and previous research on elk from Wisconsin, Ontario, Michigan, and western Minnesota to develop Habitat Suitability estimates for the study area. These data will consist of resource selection patterns and population growth rates through time. Based on our data that quantify the distribution of resources and previous research on elk physiology and behavior, we will develop approximate carrying capacities for a variety of potential release sites within the study area. We will combine the Ecological and Social maps to identify areas where restoration efforts are more likely to succeed. Our final feasibility report will summarize the strengths and weaknesses for different release sites with the goal to provide managers with the information they need to decide if an elk restoration is feasible, and if so where it will have the greatest likelihood of success in the study area.

Summary Budget Information for Activity 2

ENRTF Budget: $ 158,393
Amount Spent: $ 158,393
Balance: $ 0

Outcome	Completion Date
1. Identify primary elk study areas using existing data.	*May 2017*
2. Complete forage surveys (visit 120 sites distributed among primary land-cover types to estimate quality and abundance of common elk forage species).	*September 2017*
3. Ground truth land-cover and forage availability maps (visit 250 sites to confirm cover types).	*August 2018*
4. Complete ecological carrying capacity map and population estimation.	*December 2018*
5. Complete final suitability map and feasibility report.	*June 2019*

Activity Status as of 2 December 2016:

Forester and Schrage have begun collecting GIS layers for this project and discussing potential study areas with MN DNR staff as well as county and tribal land managers. They have also created an initial draft of a simulation model that will be used to explore potential spread of elk given landscape patterns and resource selection; this model will contribute to the population estimation efforts over the next two years.

Activity Status as of 30 June 2017:
Three ecological study areas have been identified, all centered on large tracts of public land (the Cloquet Valley, Fond du Lac, and Nemadji State Forests). Forester and Mark Ditmer (hired as a postdoc on this project) refined the vegetation sampling protocol and generated stratified random sample points for all relevant land-cover types throughout the three study areas. In early June, we trained a four-person field crew on vegetation sampling methods. This crew began collecting vegetation and cover data in mid June and will have finished data collection by the end of August.

Activity Status as of 31 January 2018:
Our four-person field crew collected vegetation and land cover data from 112 locations in the 3 ecological study areas (tracts of public land centered on the Cloquet Valley, Fond du Lac, and Nemadji State Forests). We conducted preliminary analyses that (1) estimated forage biomass at each of the sampling locations, and (2) compared forage biomass between cover types. We also compiled and assessed publicly-available spatial data that will be used for future analysis. Nick McCann was hired as a Postdoctoral Associate, replacing Mark Ditmer. McCann will work with Forester, Schrage, Fulton, and Walberg to help complete this project. Planning is underway for fieldwork that is to take place in summer 2018. Fieldwork in 2018 will focus on sampling private lands within the 3 study areas.

Activity Status as of 30 June 2018:
Vegetation sampling is occurring primarily on private lands in 2019. Sampling on private lands, in addition to public lands that were sampled in 2018, will provide an understanding of what type of food is available to elk that is more complete. Using a random-stratified approach, we selected private land parcels to sample from the pool of landowners that said it was OK to contact them on the landowner survey conducted for Activity 1. We then emailed and called 86 landowners to determine if they would allow us on their land for research, and we were granted access to 76 parcels. We also devised a protocol for sampling in rights-of-way (e.g., roadsides and areas adjacent to transmission lines) and contacted foresters and land managers to acquire GIS data that depicts recent land use (e.g., timber harvest). We hired and trained a four-person field crew for vegetation sampling, which began in early June and will end in late August.

Activity Status as of 31 January 2019:
We completed vegetation sampling in August 2018, resulting in data from a total 186 sampled plots across both years (63 in the Cloquet Valley study area; 69 in the Fond du Lac; and 54 in the Nemadji). Additional vegetation sampling was completed along roadsides and other right of ways at 31 locations (8 in the Cloquet Valley study area; 13 in the Fond du Lac; and 10 in the Nemadji), resulting in a total of 217 sampling locations across the two summers that we sampled. Data were validated and organized, and preliminary habitat analysis were completed. Additionally, we are evaluating methods by which to combine results from the human dimensions surveys with habitat analyses. Analysis is ongoing.

Final Report Summary:
We used multiple methods to evaluate and map elk habitat suitability and social support. We measured potential summer (leaf-on) and winter (leaf-off) forage in the field and combined forage data with remotely sensed data to estimate the number of elk likely to be supported by each study area. We mapped habitat suitability index scores and a resource selection function, each developed in Wisconsin. Data from roads, feedlots, row crops, and hay and pasture fields enabled us to create a risk map for human-elk conflict, and data from mail-in questionnaires enabled us to map support for elk restoration by landowners and local residents. We ranked study areas and tested the influence of considering some factors as being more important than

others. Our results show that habitat suitability and landowner support are not limiting factors for restoring elk to northeastern Minnesota.

By sampling 186 field plots, we found that mean summer forage at field plots exceeded amounts elk prefer and winter forage matched amounts where elk occur in Wisconsin. Public land had more winter forage than private land, forested shrub wetlands had more winter forage than grasslands, and grasslands had more summer forage than coniferous forests and mixed forests. Estimates of how many elk are likely to be supported (5 to 8 elk/6 mi^2) indicate that northeastern Minnesota can support densities similar to Wisconsin and Michigan. Estimates of biological carrying capacity ranged from 287 on the Fond du Lac study area to 551 elk on the Cloquet Valley study area.

Each of the 3 study areas had large amounts of habitat with suitability scores similar to where elk occur in Wisconsin. The Cloquet Valley study area contained about 4-times more suitable habitat than the Black River Herd's core area in Wisconsin, while the Nemadji study area contained about 2-times more, and the Fond du Lac study area contained about the same amount. Resource selection function maps showed the greatest amount of summer elk habitat on the Nemadji study area. When we excluded the influence of wolf territories in selection calculations (because we lacked recent wolf data from the Nemadji study area), the Nemadji study area had higher selection scores than the Cloquet Valley and Fond du Lac study areas. Aspen was more abundant in the Cloquet Valley study area than in the other study areas, while grassland was distributed similarly across the study areas. Public land made up the majority of all 3 study areas and was most abundant on the Cloquet Valley study area than in the other study areas.

Most landowners and local residents supported elk restoration, and support was similar across study areas. Overall, 82% of landowners (people who owned ≥ 4 ha of land) inside the 3 study area boundaries and 86% local residents (owned < 4 ha of land) with addresses inside the 3 study area boundaries expressed favorable attitudes toward elk restoration. Using questionnaire responses from 2,585 landowners and 1,521 local residents from inside and outside the study areas, we mapped social acceptance scores and found landowner and local resident acceptance was high.

Human-elk conflict risk was low on the 3 study areas, but increased from north to south, with the Nemadji study area having mean risk 5-times greater than for the Cloquet Valley study area. Low conflict risk in all directions adjacent to the Cloquet Valley study area may enable elk population expansion without eroding public support. The same is true to the west, north, and east of the Fond du Lac study area, but areas outside the Nemadji study area (in all directions within the state), had higher risk of human-elk conflict.

Considering the factors that we assessed to be equally important (i.e., evenly weighing them) did not result in statistically different study area rankings (on average, all 3 study areas were about the same). Some study areas ranked better than others, however, when we weighted factors (considered some factor to be more important than others). The Cloquet Valley study area ranked best most often (after weightings), followed by the Nemadji study area and the Fond du Lac study area.

V. DISSEMINATION:

Description: The workshops in Activity 1 will provide a direct outlet to share our findings with the public. A fact sheet that summarizes our findings will be distributed to LCCMR members and land managers at the state and federal level; this will also be made available on the UMN Department of Fisheries, Wildlife, and Conservation Biology website. Results will be presented at state and national wildlife and ecology conferences (e.g., both state and national conferences of The Wildlife Society, the Society for Conservation Biology). Any publications resulting from this project will be made available through the FWCB website or Open Access journal websites.

We also expect that there will be a large amount of informal dissemination because we will be working closely with researchers and managers from the Department of Natural Resources, county governments, and the Fond

du Lac Band of Lake Superior Chippewa. These researchers will take the results of our study into consideration as they make management decisions and will work with us to ensure that our data products reach a broad audience within their agencies.

Status as of 2 December 2016**:**
We are including the MN DNR, county, and tribal land managers in our planning efforts, but do not yet have any results to disseminate.

Status as of 30 June 2017**:**
Schrage, Forester, and Fulton worked closely with University, DNR Area Wildlife staff, and county and tribal land managers to finalize the three proposed focal study areas; this was completed in March, 2017. Schrage gave two presentations on the project at Rocky Mountain Elk Foundation banquets in Duluth and Prior Lake; another elk project presentation was given to the Minnesota Sharp-tailed Grouse Society in Hinckley. Forester, Schrage, and Fulton were interviewed about the elk project for an Outdoor News article that was published on 15 June. We have also developed an internet presence, including a website (http://elk.umn.edu) and Facebook page (https://www.facebook.com/NE.MN.elk).

Status as of 31 January 2018**:**
We held 3 project meetings that included discussion of preliminary results with staff from the DNR. Schrage gave presentations describing this project and elk restoration to the Winton Historical Society, staff from the DNR's Northwest Region, and the Minnesota Soil and Water Conservation District Forestry Association. In addition, educational displays about elk and the idea of elk restoration in northeast Minnesota were set up and staffed by tribal, Rocky Mountain Elk Foundation, University of Minnesota, and volunteer staff at the Carlton County and Minnesota State Fairs.

The number of followers of the elk project's Facebook site has grown to 156. In fall 2017 this project was featured in the Duluth News Tribune, Pioneer Press, Brainerd Dispatch, and the Minnesota Deer Hunters Association publication of "Whitetales".

Status as of 30 June 2018**:**
Schrage and McCann ran an informational booth for the project at the Outdoor News Deer and Turkey Classic show. Schrage gave a presentation at the annual meeting of the Minnesota Division of the Izaak Walton League. Additional outreach and dissemination efforts continue through a website and a Facebook page that we created to keep citizens informed of our research. The website was created to provide information about elk in Minnesota and restoration efforts in the eastern United States, along with providing summaries of the research projects to be conducted. The Facebook page was created to provide instantaneous communication with interested citizens with relevant updates about the research projects.

Status as of 31 January 2019**:**
Schrage gave presentations on elk restoration to the Breckinridge Chapter of the Izaak Walton League, Rocky Mountain Elk Foundation members in the Twin Cities, and at the Moose Lake Covenant Church Outdoor Expo. Schrage and other tribal personnel staffed two booths that highlighted this project, one at the Minnesota State Fair and a second at the Cloquet Forestry Center's 50th anniversary celebration of their Conservation Education Day event. Outreach and dissemination efforts continue through a website and a Facebook page that we created to keep citizens informed of our research. The number of followers of the project's Facebook site has grown to 198.

Final Report Summary:
Schrage delivered 16 presentations about this project to multiple groups, including: Rocky Mountain Elk Foundation banquets in Duluth and Prior Lake, the Minnesota Sharp-tailed Grouse Society in Hinckley, the Winton Historical Society, staff from the MNDNR's Northwest Region, the Minnesota Soil and Water

Conservation District Forestry Association, the Breckinridge Chapter of the Izaak Walton League, Rocky Mountain Elk Foundation members in the Twin Cities, the Moose Lake Covenant Church Outdoor Expo, the annual meeting of the Minnesota Division of the Izaak Walton League, the Minnesota Forest Resources Partnership, St. Louis County Leaseholders, Northwoods Audubon, MNDNR Region 2 Assistant Wildlife Managers, a joint meeting of Minnesota Forest Industries and MNDNR Forestry, and at a meeting of the St. Louis County Committee of the Whole. McCann and Walberg delivered presentations about the project at the joint meeting of the State Chapters of The Wildlife Society and Society of American Foresters in Duluth, MN. Fulton and McCann delivered presentations about the project at the Western Association of Fish and Wildlife Agencies' Biennial Deer & Elk Workshop in Marfa, TX. This project was featured in the Duluth News Tribune, Pioneer Press, Brainerd Dispatch, the Minnesota Deer Hunters Association publication of "Whitetales", and Outdoor News. Educational displays about elk and this project were set up and staffed by tribal, Rocky Mountain Elk Foundation, University of Minnesota, and volunteer staff at the Carlton County and Minnesota State Fairs. Additionally, Schrage and other tribal personnel staffed booths that highlighted this project at the Minnesota State Fair and a second at the Cloquet Forestry Center's 50th anniversary celebration of their Conservation Education Day event, and Schrage and McCann ran an informational booth for the project at the Outdoor News Deer and Turkey Classic show. We held multiple project meetings that included MNDNR staff. We developed an internet presence, including a website (http://elk.umn.edu) and Facebook page (https://www.facebook.com/NE.MN.elk). Detailed final reports for each Activity were produced and will be provided to MN DNR and other management agencies.

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 281,029	1 project manager at 8%FTE for 3y; 1 postdoc at 100% FTE for 2y; 1 PhD student at 50% FTE for 2 y; 1 lab technician at 8% FTE for 3 y; 2 undergraduate research assistants at 15%FTE for 1y; 4 undergraduate research assistants at 17% FTE for 2y.
Professional/Technical/Service Contracts:	$4,579	Mailing services for survey
Equipment/Tools/Supplies	$3,033	Sample bags, tablets and GPS for data entry, drying oven, and postage
Travel Expenses in MN:	$11,359	Travel to study area by project management staff and technicians 3 months/yr for 2 years; partial room and board for field crew.
Other:	$0	
TOTAL ENRTF BUDGET:	**$300,000**	

Explanation of Use of Classified Staff: NA

Explanation of Capital Expenditures Greater Than $5,000: NA

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 4.9

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 0

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			

Fond du Lac Band	$15,000	$15,000	internal funding to support survey materials Survey materials (envelopes, paper, printing costs, etc: 12182 surveys $1.25 each)
Fond du Lac Band	$26,400	$26,400	Pending - external funding to support field effort (room and board for field crew, equipment, postage)
Rocky Mountain Elk Foundation	$15,000	$15,000	funding to support survey incentive ($3 / completed survey)
United States Geological Survey	$32,000	$32,000	Salary for Fulton (10% match over two years)
Fond du Lac Band	$27,799	$27,799	Salary for Schrage (10% match)
Fond du Lac Band	$8,736	$8,736	Salary for Howes (3% match)
Fond du Lac Band	$10,500	$10,500	Travel for Schrage and FDL employees for elk research
State			
UMN research funds from Forester	$3,158	$3,158	
UMN foregone Indirect Cost Recovery funding	$137,023	$137,023	52% of direct costs, excluding graduate fringe
TOTAL OTHER FUNDS:	**$275,616**	**$275,616**	

VII. PROJECT STRATEGY:

A. Project Partners:

A research team will be led by scientists from the University of Minnesota Department of Fisheries, Wildlife, and Conservation Biology (Dr. James Forester) and MN Cooperative Fish & Wildlife Research Unit (Dr. David Fulton) and the Fond du Lac Resource Management Division (Mike Schrage and Tom Howes). Forester will oversee the ecological portion of the project while Fulton will take the lead on the public attitude and acceptance survey. We will support a PhD level graduate student and a postdoctoral research associate on this project (advised by Forester and Fulton) and will receive support from the Fond du Lac Band and the Rocky Mountain Elk Foundation. Carlton, St. Louis, and Pine Counties, and the Minnesota Department of Natural Resources are not receiving funding, but are supporting this application and will provide data on forest management and land use. Other local and statewide conservation organizations have written letters of support for conducting this initial feasibility study.

B. Project Impact and Long-term Strategy:

If this study demonstrates there is sufficient public support and suitable habitat, then the next steps in the process for restoring elk to Northeastern Minnesota can be taken. Further, we will develop a research framework that could be applied to other areas of the state where citizens are interested in exploring the feasibility of elk restoration. The proposed work builds on moose research by the MNDNR in NW Minnesota to examine how this species is responding to a variety of landscapes. This study will directly address questions of management concern and will also advance managers' understanding of (1) the strength of public support for an elk restoration in NE Minnesota; (2) where a reintroduced elk population would be most likely to thrive based on the landscape-scale distribution of forage and land cover; and (3) where areas of social support and high-quality elk habitat overlap. Our ongoing collaborations with state, tribal, and federal agencies will ensure that the research results are broadly disseminated and that they will be used to help determine if elk restoration in this area is feasable in the future.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
Mike Schrage and Tom Howes from the Fond du Lac Band have	2014-2015	$14,632

given 20 presentations to local county governments and the public on this topic to build initial support for this plan. In addition, Mike has attended 2 Eastern Elk Workshops and traveled to Michigan and Wisconsin to better understand the issues and logistics with restoring elk populations. Funding has come from internal Fond du Lac Band funding sources to cover time and travel expenses.		
		$
		$

IX. VISUAL COMPONENT or MAP(S):

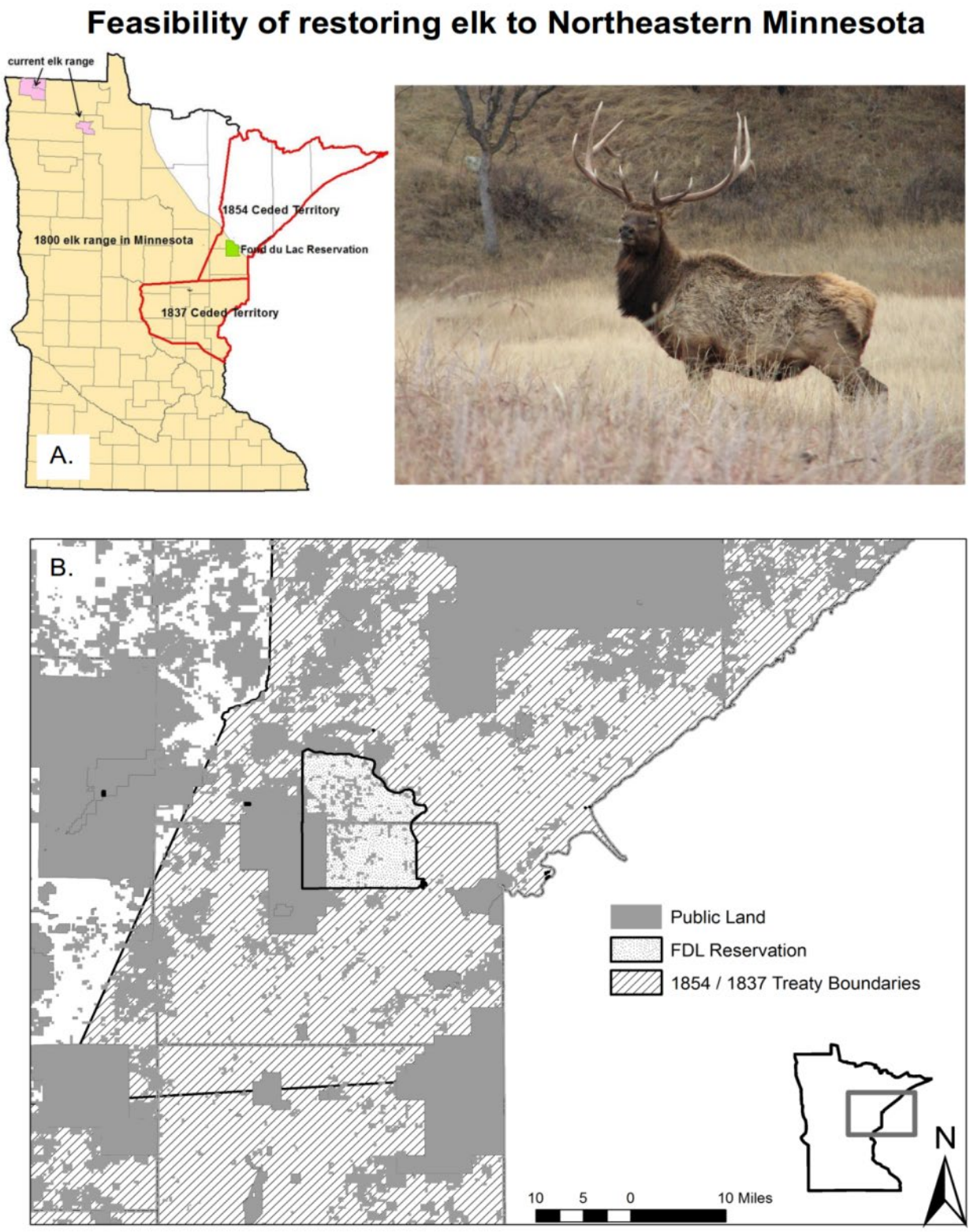

Figure 1: A. Historic and current range of elk in Minnesota. **B.** The proposed study area in Northeastern MN. A combination of public opinion surveys and workshops along with GIS mapping, air photos, and field surveys of habitat characteristics will identify areas with sufficient public support and suitable habitat for restoring an elk population.

X. RESEARCH ADDENDUM: NA

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than 2 December 2016, 30 June 2017, 31 January 2018, 30 June 2018, and 31 January 2019. A final report and associated products will be submitted between June 30 and August 15, 2019.

Environment and Natural Resources Trust Fund
M.L. 2016 Project Budget

Project Title: Restoration of Elk to Northeastern Minnesota
Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd 03l
Project Manager: James D Forester
Organization: University of Minnesota
M.L. 2016 ENRTF Appropriation: $300,000
Project Length and Completion Date: 3 Years, June 30, 2019
Date of Report: 2019-08-16

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Revised Activity 1 Budget 02/26/2019	Amount Spent	Activity 1 Balance	Revised Activity 2 Budget 02/26/2019	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM								
Personnel (Wages and Benefits)	$137,028	$137,028	$0	$144,001	$144,001	$0	$281,029	$0
Faculty (Forester) - 8%FTE = 1mo summer salary per year over 3yr ($25,519) plus 33.8% fringe ($8,625): will manage project, and take lead on supervise the collection and analysis of elk habitat data (total = $34,144).								
Postdoctoral scholar $22/hr 100% FTE for two years (annually: $45,760 salary, $9,793 fringe; total = $111,106): Will lead field and GIS data collection and analysis efforts, and create final combined suitability map.								
PhD student $21/hr 50% FTE for two years (annually: $21,723 salary, $18,848 fringe and tuition, total = $79,941): Will lead stakeholder engagement survey efforts.								
Undergraduate lab assistants – 3-4 students, working a total of 624h over 1 yr, $15/h: will complete survey mailing and aid graduate students with data entry of survey results (total 30% FTE for 1 yr = $9,360)								
Undergraduate field and lab assistants – 3-4 students, 40h/wk, 10 wks over 2 yr, $15/h: will aid graduate student and postdoc with data collection and entry. (total 70% FTE /yr for 2 years = $43,600)								
Professional/Technical/Service Contracts	$4,579	$4,579	$0				$4,579	$0
Mailing services and postage for surveys (UMN mailing service)								
Equipment/Tools/Supplies	0	$0	$0	$3,033	$3,033	$0	$3,033	$0

field equipment (cloth sample bags 323 x $1.50)								
Tablets for data entry (1 x $250)								
Handheld GPS units (1 x $530)								
Compasses (standard sighting compasses 2 x $45)								
Drying oven (for drying vegetation biomass samples) $2832								
Travel expenses in Minnesota				$11,359	$11,359	$0	$11,359	$0
Travel to study area by project management staff and technicians 3 months/yr for 2 years (1 fleet truck @$818/month, $0.37/mi, 9000 miles/ yr)								
Room and board for field crew (2 yr of summer field sessions, 3 months/yr, 6 crew members at a time, rent @ $1,500/mo, board@$1,240/mo) -- Fond du Lac Band will cover $15,000 of these costs								
COLUMN TOTAL	**$141,607**	**$141,607**	**$0**	**$158,393**	**$158,393**	**$0**	**$300,000**	**$0**

Feasibility of restoring elk to northeastern Minnesota: habitat availability and social acceptance

A cooperative study conducted by:
Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota

Minnesota Cooperative Fish and Wildlife Research Unit

Fond du Lac Band of Lake Superior Chippewa

Feasibility of restoring elk to northeastern Minnesota: habitat availability and social acceptance

Prepared by:
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University of Minnesota

Acknowledgements

We thank the many private landowners and local residents who allowed us to access their land, participated in focus groups, and responded to questionnaires. M. Ditmer and J. Berini assisted with developing field methods. G. Barnas, A. Erickson, M. Kaminski, C. Minnick, M. Mullin, J. Wagner, T. Weise, and S. Wesche collected field data. L. Cornicelli, L. McInenly, C. Balzar, G. Bernu, G. Beck, S. Olson, T. Rusch, N. Hansen and J. Meyer assisted with study design and questionnaire development. L. Cornicelli, B. Keller, A. Landon, and L. McInenly reviewed drafts of this report. W. Bartsch, C. Beal, J. Erb, W. Hakala, C. Humpal, J. Kelash, D. Ryan, M. Swigen, M. Westphal, and D. Wilson provided GIS data. D. Beyer, H. Campa III, B. Dhuey, J. Gilbert, and C. Williamson provided habitat suitability model information. The Environment and Natural Resources Trust Fund, Minnesota Cooperative Fish and Wildlife Research Unit, Fond du Lac Resource Management Division, Great Lakes Restoration Initiative, and Rocky Mountain Elk Foundation provided funding and other support for this project.

Suggested Citation

McCann, N.P., Walberg, E.M., Forester, J.D., and Schrage, M.W. 2019. Feasibility of restoring elk to northeastern Minnesota: habitat availability and social acceptance. University of Minnesota, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, Minnesota.

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Executive summary

Elk (*Cervus canadensis*) once ranged across most of Minnesota but were functionally extirpated by the early 1900s. Three groups occur in northwestern Minnesota but are managed at low levels (Figure S-1). This study examines the feasibility of restoring elk to northeastern Minnesota. It provides information for determining where elk restoration will be successful, should it occur, including information about habitat suitability, social acceptance, and human-elk conflict.

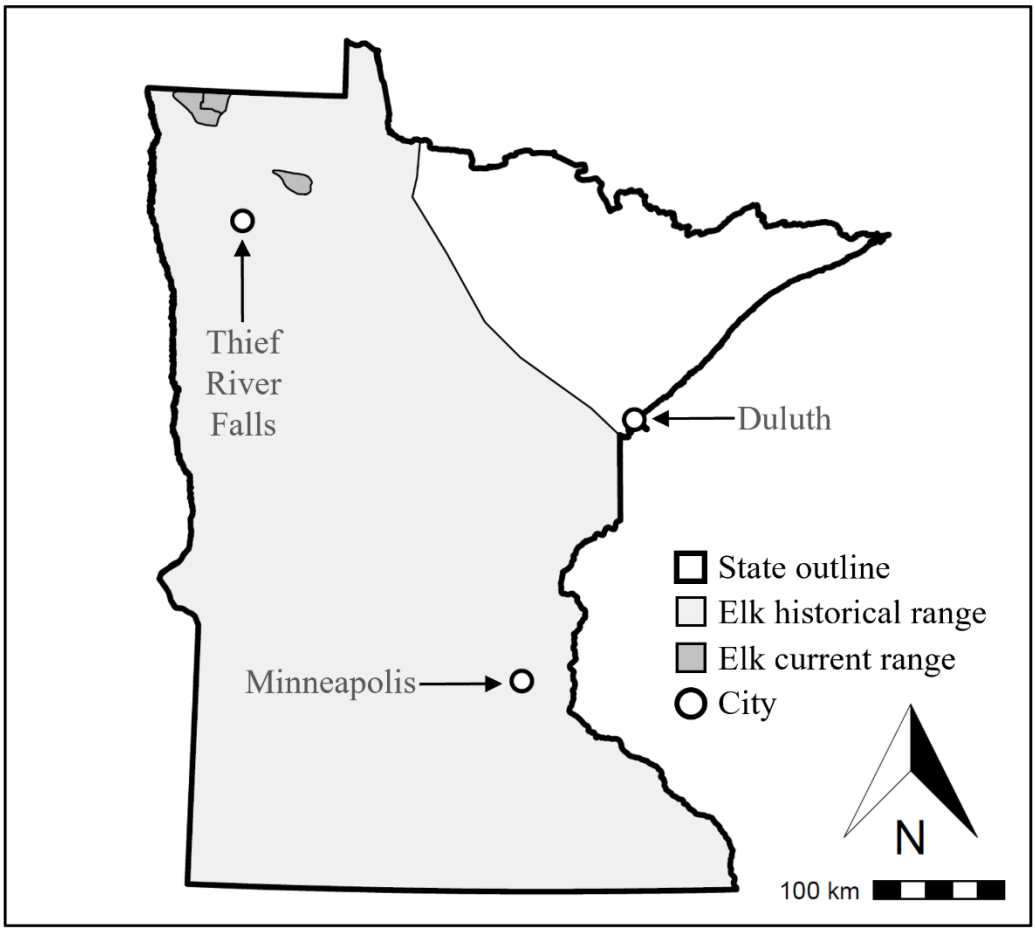

Figure S-1. Historical and current elk range in Minnesota. Some larger cities are included to serve as references. Scalebar: 100 km = 62 mi.

We studied habitat suitability and public support for elk on and near 3 study areas in northeastern Minnesota (Figure S-2). The Cloquet Valley study area was 1,764 km^2 (681 mi^2), the Fond du Lac study area was 766 km^2 (296 mi^2), and the Nemadji study area was 963 km^2 (372 mi^2). Study areas were comprised mostly of public land (60 to 75%) and had low road densities (0.96 km/km^2; 1.55 mi/mi^2) that are suitable for elk (< 2 km/km^2; 3.22 mi/mi^2).

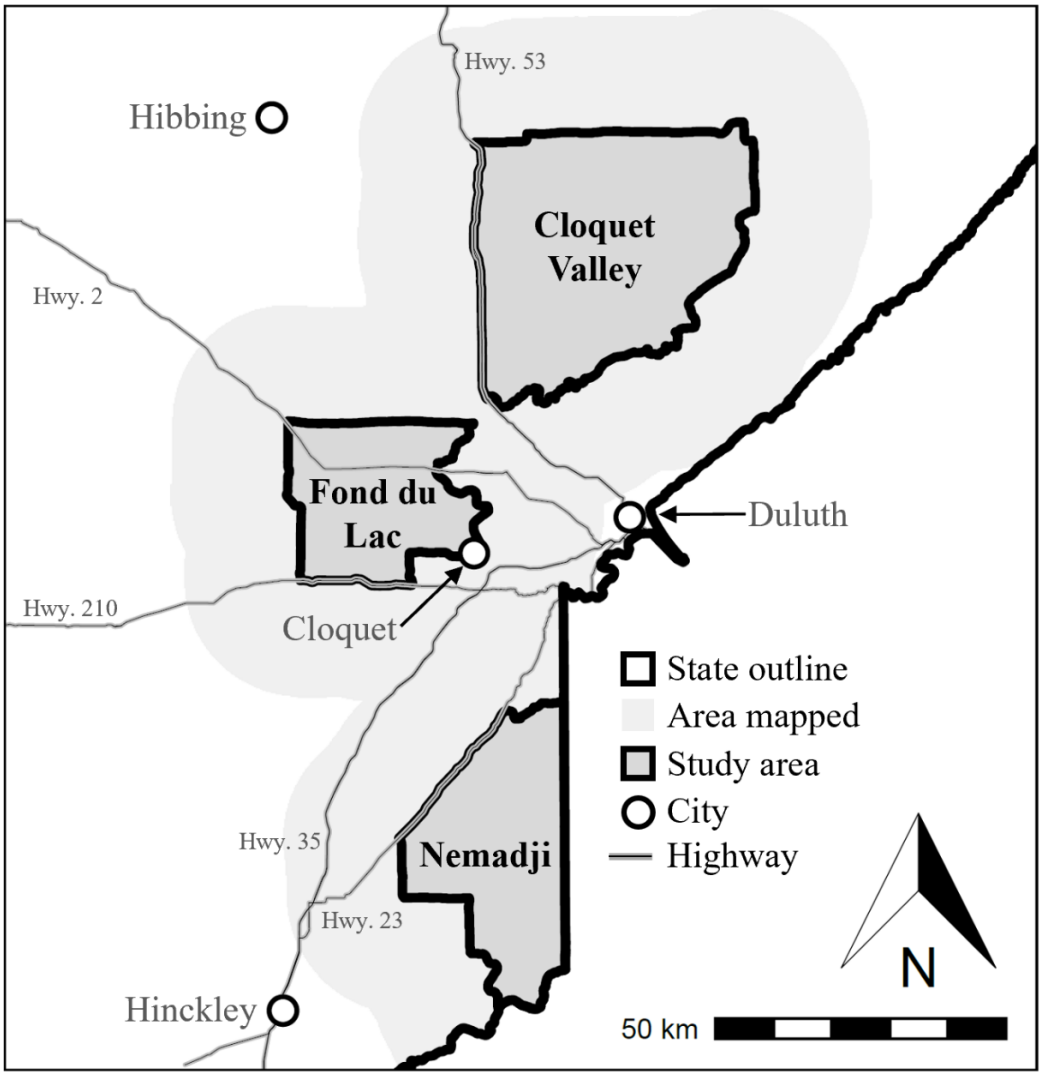

Figure S-2. Study areas in northeastern Minnesota where we studied the feasibility of restoring elk. Larger cities and highways included to serve as references. Maps we created were for the 3 study areas and the 20 km (12 mi) surrounding them. Scalebar: 50 km = 31 mi.

We used multiple methods to evaluate and map elk habitat suitability and social support. We measured potential summer (leaf-on) and winter (leaf-off) forage in the field and combined forage data with remotely sensed data to estimate the number of elk likely to be supported by each study area. We mapped habitat suitability index scores and a resource selection function, each developed in Wisconsin. Data from roads, feedlots[1], row crops, and hay and pasture fields enabled us to create a risk map for human-elk conflict, and data from mail-in questionnaires

[1] Feedlots, as defined by the state of Minnesota, are open land without maintained vegetation and buildings where producers hold animals for feeding. Pastures are not feedlots but the 2 often occur together (MPCA 2007).

enabled us to map support for elk restoration by landowners and local residents. In the end, we ranked study areas and tested the influence of considering some factors as being more important than others. Our findings show that habitat suitability and landowner support are not limiting factors for restoring elk to northeastern Minnesota.

Key finding 1: Mean summer forage at field plots exceeded amounts elk prefer and winter forage matched amounts where elk occur in Wisconsin.

We sampled 186 field plots: 63 plots on the Cloquet Valley study area, 69 on the Fond du Lac study area, and 54 on the Nemadji study area. Public land had more winter forage than private land, forested shrub wetlands had more winter forage than grasslands, and grasslands had more summer forage than coniferous forests and mixed forests. Mean summer forage at field plots was 0.130 kg/m^2 (0.426 oz/ft^2) and mean winter forage was 0.017 kg/m^2 (0.056 oz/ft^2).

Key finding 2: Our estimates of how many elk are likely to be supported during winter indicate that northeastern Minnesota can support densities similar to Wisconsin and Michigan.

Mean estimates of how many elk likely to be supported during winter on each study area ranged from 5 to 8 elk/16 km^2 (5 to 8 elk/6 mi^2; Figure S-3). These estimates correspond well with elk densities in Wisconsin's Black River Herd and in Michigan, and they are higher than Wisconsin's Clam Lake Herd. Estimates of how many elk likely to be supported during summer were much higher, ranging from 14 to 83 elk/16 km^2 (14 to 83 elk/6 mi^2) across the study areas. We focused on winter when determining how many elk can be supported, however, as it is the limiting season for wildlife population growth, including for elk.

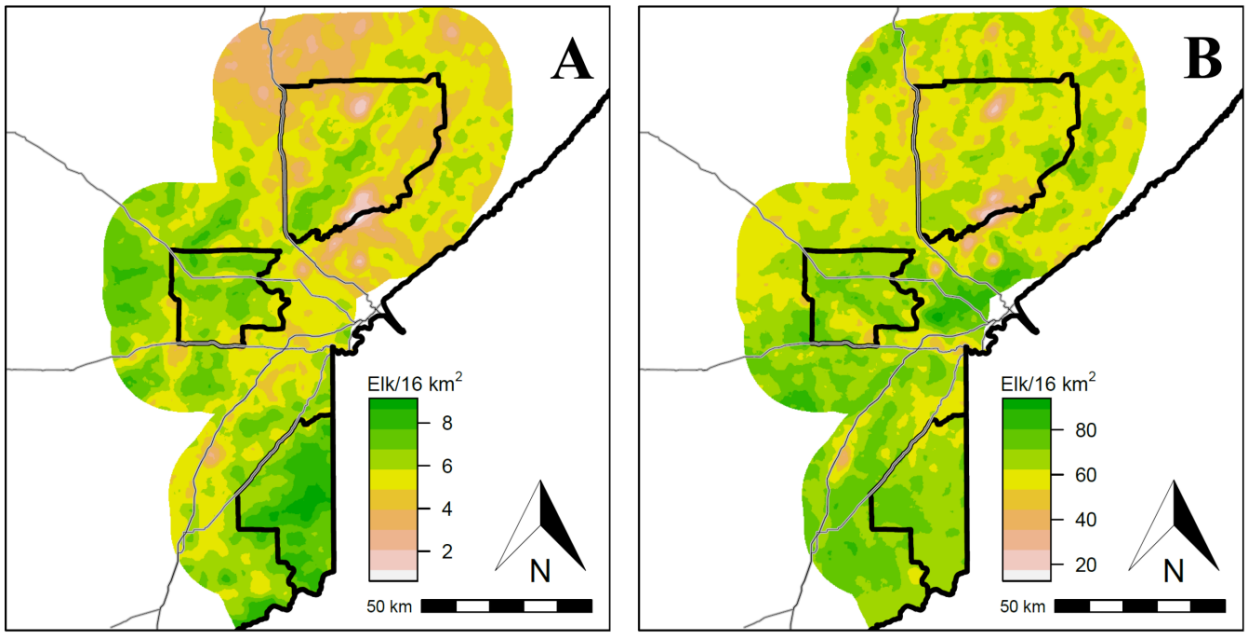

Figure S-3. Estimates of how many elk likely to be supported during winter (A) and summer (B) in northeastern Minnesota. Scalebar: 16 km^2 = 6 mi^2 and 50 km = 31 mi.

Key finding 3: Estimates of biological carrying capacity ranged from 287 on the Fond du Lac study area to 551 elk on the Cloquet Valley study area.

Carrying capacity estimates based on how many elk are likely to be supported during winter are in Table S-1. These estimates probably underestimate biological carrying capacity as we assumed elk consume only a small proportion of available forage. Estimates also do not account for cultural carrying capacity, which may be different.

Table S-1. Winter biological carrying capacity estimates for 3 study areas in northeastern Minnesota. Estimates are for the 3 study areas but not the surrounding areas.

Study area	Area (km^2)	Area (mi^2)	Carrying capacity (range)
Cloquet Valley	1,764	681	551 (335 to 768)
Fond du Lac	766	296	287 (193 to 381)
Nemadji	963	372	481 (364 to 599)

Key finding 4: Each of the 3 study areas had large amounts of habitat with suitability scores similar to where elk occur in Wisconsin.

Suitability maps of winter forage (Figure S-4A), spring forage (Figure S-4B), and winter cover (Figure S-4C) resulted in a map of overall suitability (Figure S-4D), ranging from 0 to 0.68 (higher values are better). The Cloquet Valley study area contained about 4-times more suitable habitat than the Black River Herd's core area in Wisconsin, while the Nemadji study area contained about 2-times more, and the Fond du Lac study area contained about the same amount.

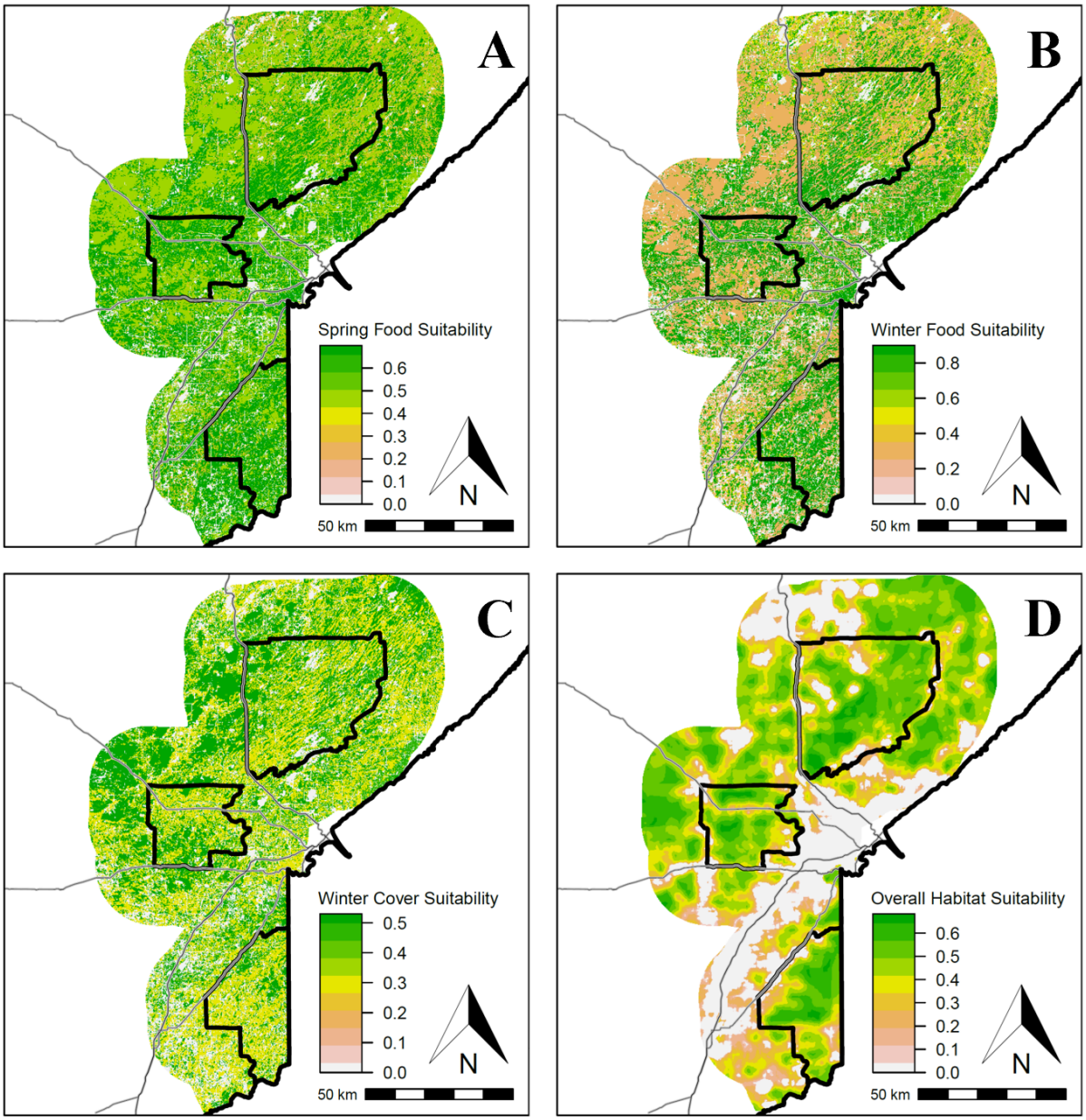

Figure S-4. Spring food (A), winter food (B), winter cover (C), and overall suitability indices (D) for elk in northeastern Minnesota when a habitat suitability model from Wisconsin was used. Higher values indicate better suitability. Scalebar: 50 km = 31 mi.

Key finding 5: Resource selection function maps showed the greatest amount of summer elk habitat on the Nemadji study area.

Summer resource selection function scores reflected increasing relative probability of selection (1 = low probability and 4 = high probability). When we included known wolf territories in relative selection calculations, the Nemadji study area had mean selection scores 2.6- and 3-times higher than the Cloquet and Fond du Lac study areas (Figure S-5A). Selection was high on the Nemadji study area because wolf pack territory location influenced selection scores, but we were missing wolf territory data from packs that occur there. When we excluded the influence of wolf territories in selection calculations, mean selection score differences were smaller (Figure S-5B); the Nemadji study area had mean selection scores 1.5- and 1.3-times higher than the Cloquet Valley and Fond du Lac study areas.

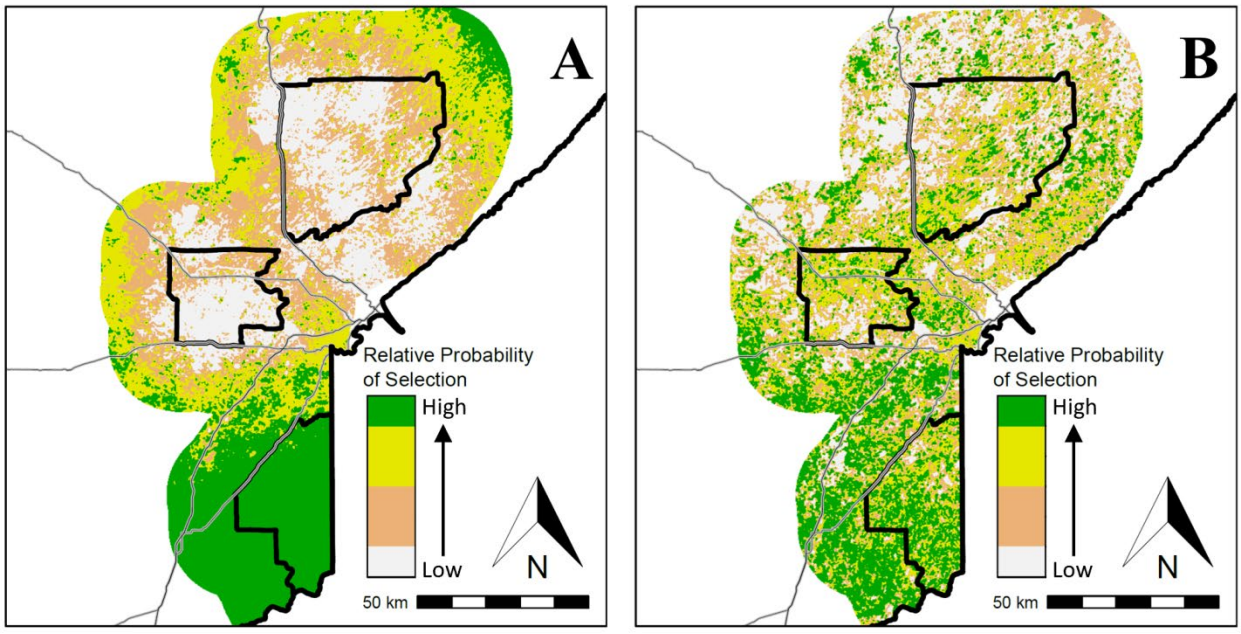

Figure S-5. Relative probability of resource selection by elk in northeastern Minnesota with (A) and without (B) influence of monitored wolf packs. Recent wolf territory data were unavailable for the Nemadji study area. Scalebar: 50 km = 31 mi.

Key finding 6: Aspen was more abundant in the Cloquet Valley study area than in the other study areas, while grassland was distributed similarly across the study areas.

Abundance of aspen (a selected elk forage) was 4.3 times greater on the Cloquet Valley study area (mean proportion = 0.17 aspen) than on the Fond du Lac study area (0.04 aspen), and 5.7 times greater than on the Nemadji study area (0.03 aspen; Figure S-6A).

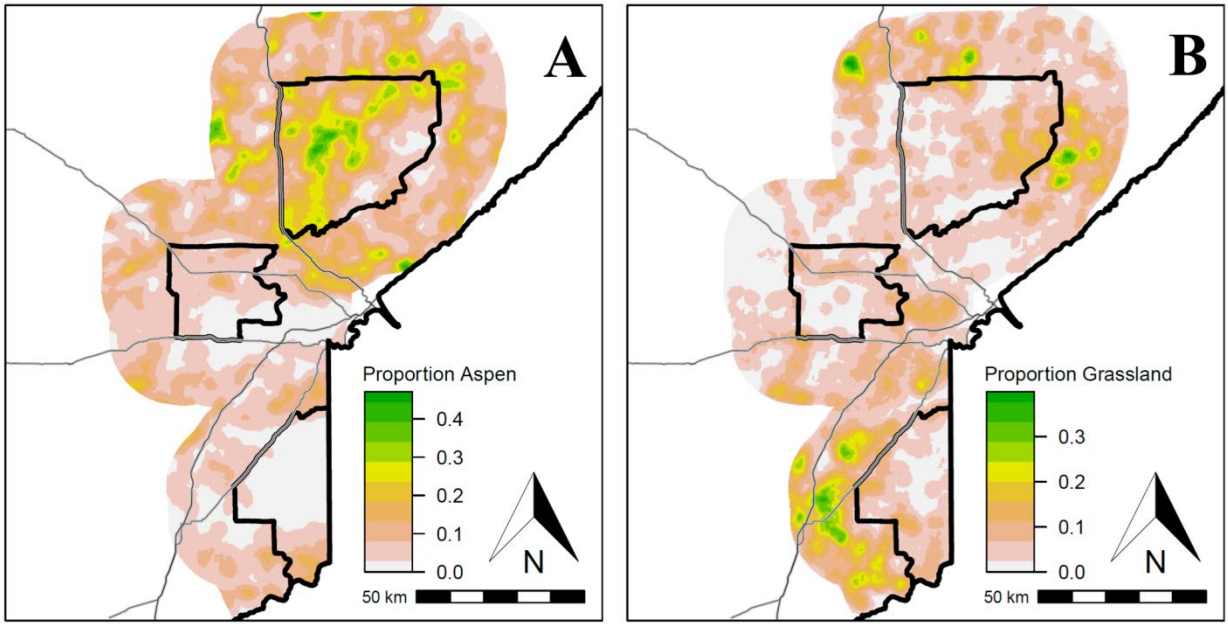

Figure S-6. Proportion of area that was aspen (A) and grassland (B) in northeastern Minnesota. Scalebar: 50 km = 31 mi.

Key finding 7: Public land made up the majority of all 3 study areas and was most abundant on the Cloquet Valley study area than in the other study areas.

The Cloquet Valley study area was 0.75 public land, while the Fond du Lac study area was 0.61 public, and the Nemadji study area was 0.60 (Figure S-7).

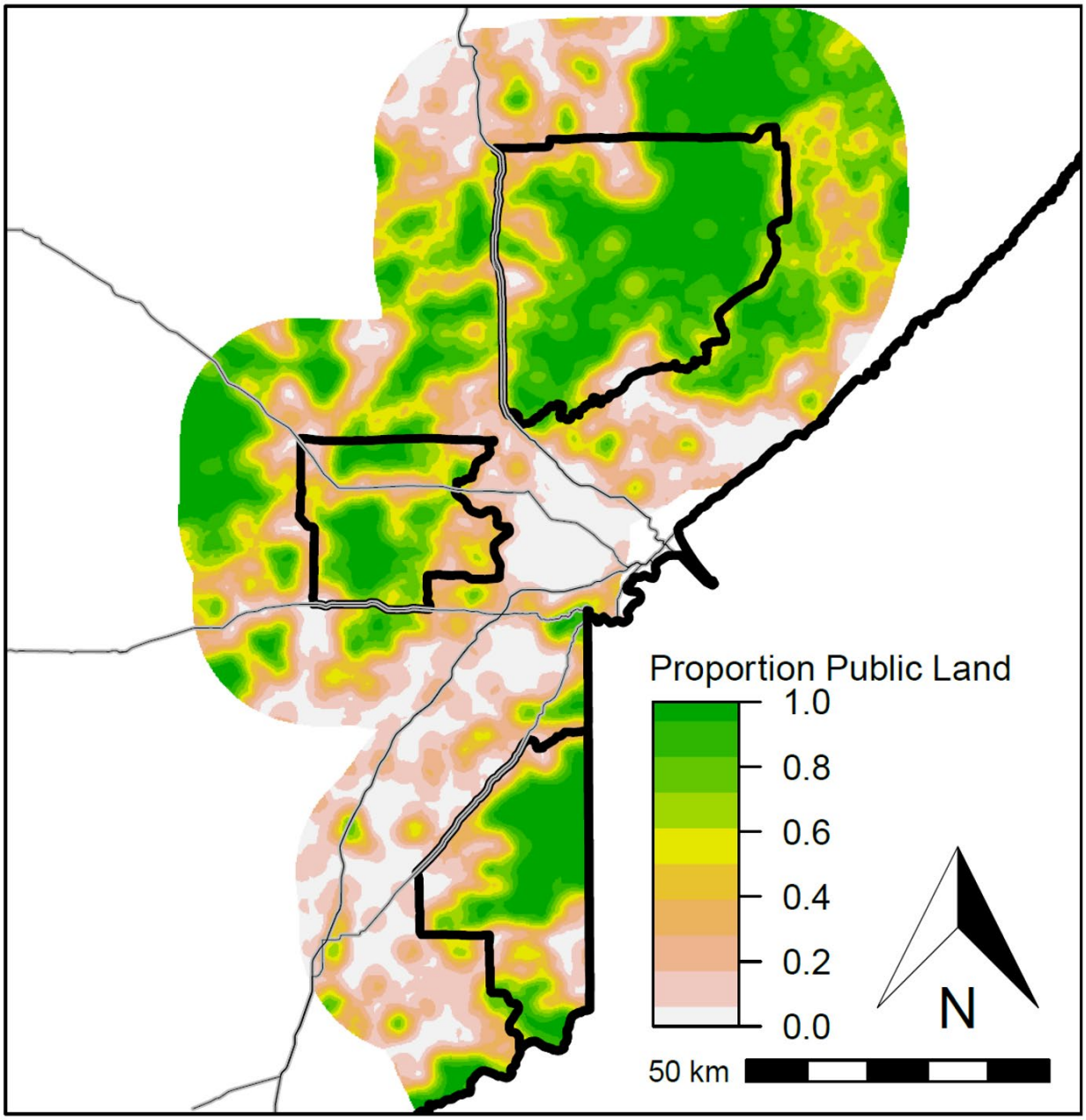

Figure S-7. Proportion of public land in northeastern Minnesota. Scalebar: 50 km = 31 mi.

Key finding 8: Most landowners and local residents supported elk restoration, and support was similar across study areas.

Overall, 82% of landowners (people who owned ≥ 4 ha of land) inside the 3 study area boundaries and 86% local residents (owned < 4 ha of land) with addresses inside the 3 study area boundaries expressed favorable attitudes toward elk restoration (Table S-2). Landowners and local residents had about the same level of acceptance for elk restoration on each study area. Our results correspond well with those from a companion study that focused on social acceptance in greater detail by Walberg et al. (2019). That study included additional statistical analysis of landowners and local residents from inside and outside the study areas.

Table S-2. Acceptance scores for landowners and local residents inside the boundaries of 3 northeastern Minnesota study areas. A companion study by Walberg et al. (2019) that included additional analysis of questionnaire responses from landowners and local residents from inside and outside study area boundaries had similar results.

	Landowners: count (proportion) of acceptance scores [a]							
Study area	1	2	3	4	5	6	7	Sum
Cloquet Valley	24 (0.07)	9 (0.03)	8 (0.02)	23 (0.07)	37 (0.11)	90 (0.27)	142 (0.43)	333
Fond du Lac	16 (0.08)	4 (0.02)	4 (0.02)	22 (0.11)	17 (0.08)	69 (0.33)	77 (0.37)	209
Nemadji	20 (0.05)	11 (0.03)	7 (0.02)	26 (0.06)	45 (0.11)	103 (0.25)	196 (0.48)	408
Sum (landowners)	60 (0.06)	24 (0.03)	19 (0.02)	71 (0.07)	99 (0.10)	262 (0.28)	415 (0.44)	950
	Local residents: count (proportion) of acceptance scores							
Study area	1	2	3	4	5	6	7	Sum
Cloquet Valley	6 (0.08)	1 (0.01)	0 (0.00)	6 (0.08)	13 (0.17)	18 (0.23)	34 (0.44)	78
Fond du Lac	0 (0.00)	1 (0.05)	0 (0.00)	1 (0.05)	4 (0.18)	8 (0.36)	8 (0.36)	22
Nemadji	1 (0.05)	0 (0.00)	0 (0.00)	1 (0.05)	2 (0.09)	8 (0.36)	10 (0.45)	22
Sum (local residents)	7 (0.06)	2 (0.02)	0 (0.00)	8 (0.07)	19 (0.10)	34 (0.28)	52 (0.43)	122

[a] 1 = low acceptance, 4 = neutral, 7 = high acceptance

Using questionnaire responses from 2,585 landowners and 1,521 local residents from inside and outside the study areas, we mapped social acceptance scores (ranging from 1 = unfavorable toward restoration to 7 highly favorable; 4 = neutral) and found landowner and local resident acceptance was high (Figure S-8). Landowner acceptance ranged from 5.5 on the Fond du Lac study area to 5.8 on the Nemadji study area, and local resident acceptance ranged from 5.4 on the Fond du Lac study area to 5.7 on the Nemadji study area.

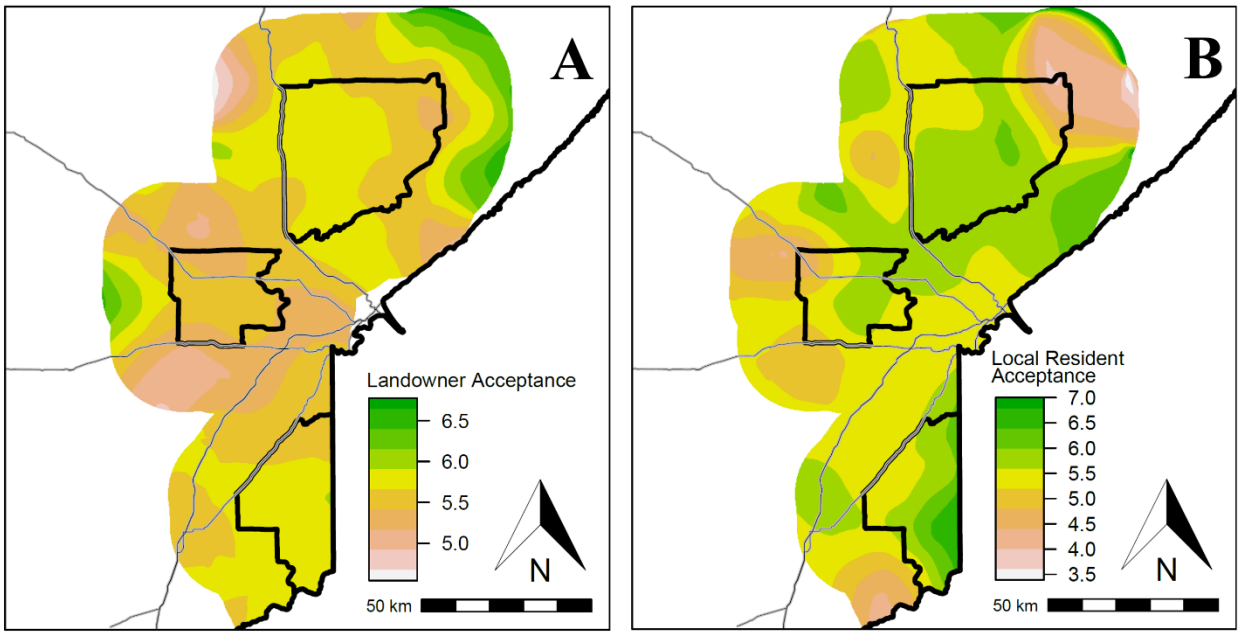

Figure S-8. Social acceptance of elk restoration by landowners (A) and local residents (B) on and near 3 study areas in northeastern Minnesota. Acceptance ranges from 1 (low) to 7 (high), with 4 being neutral. The scale bars start at values > 0 as minimum mean acceptance was 4.5 for landowners and 3.4 for local residents. Scalebar: 50 km = 31 mi.

Key finding 9: Human-elk conflict risk was low on the 3 study areas, but risk adjacent to our study areas may influence public support for elk population expansion.

Human-elk conflict risk (proportion of area made up of roads, feedlots, row crops, and hay/pasture fields) was low (mean risk ≤ 0.10) across each of the 3 study areas (Figure S-9). It increased from north to south, with the Nemadji study area having mean risk 5-times greater than for the Cloquet Valley study area. Low conflict risk in all directions adjacent to the Cloquet Valley study area may enable elk population expansion without eroding public support. The same is true to the west, north, and east of the Fond du Lac study area, but areas outside the Nemadji study area (in all directions within the state), had higher risk of human-elk conflict.

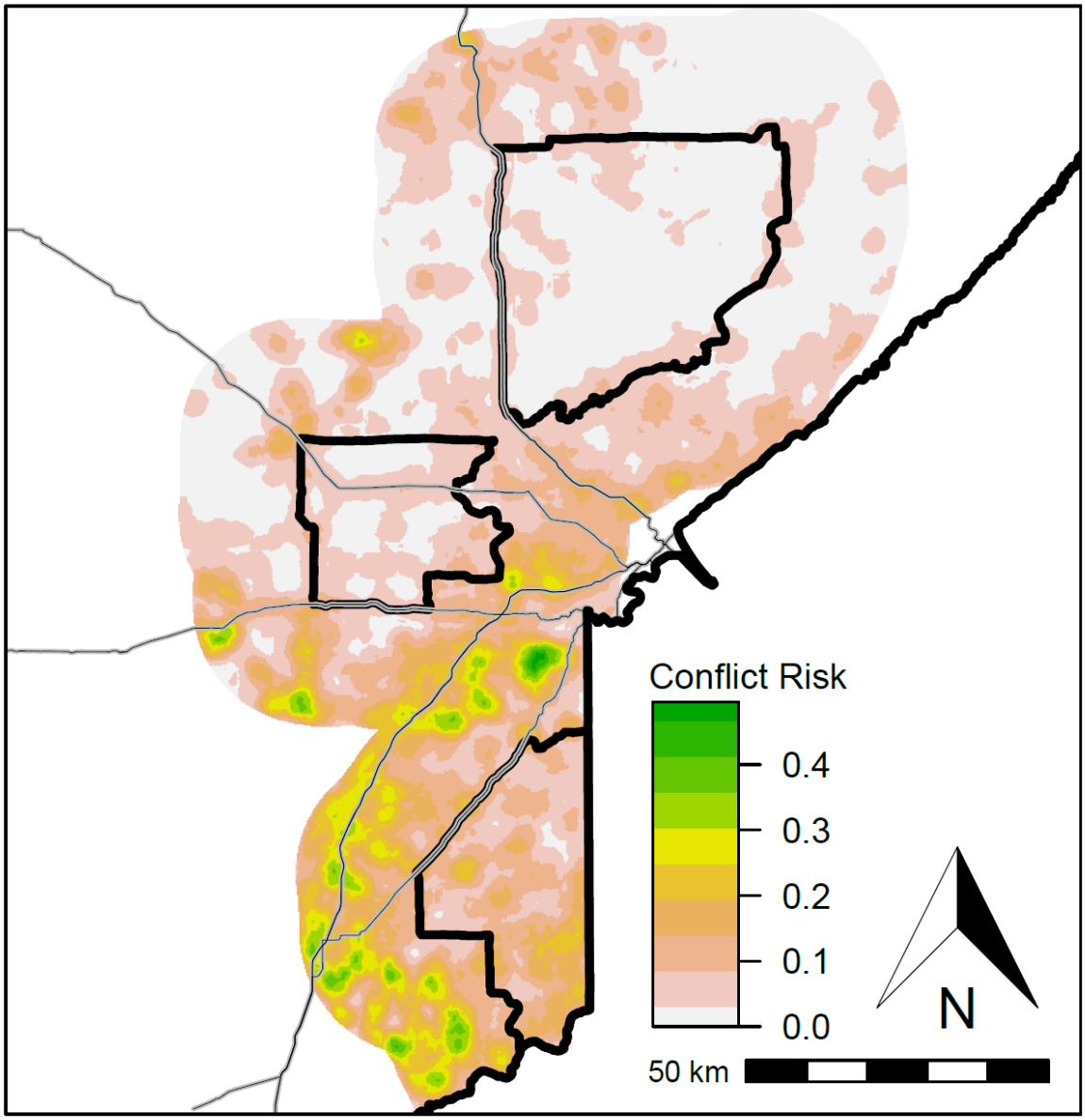

Figure S-9. Risk of human-elk conflict (proportion of area that is roads, feedlots, and row crops). Scalebar: 50 km = 31 mi.

Key finding 10: Considering factors we assessed to be equally important (evenly weighing them) did not result in statistically different study area rankings (on average, all 3 study areas were about the same). Some study areas ranked better than others, however, when we weighted factors (considered some factor to be more important than others).

It required weighting factors about 6 times to arrive at different ranks for each study area (Figure S-10), which means that a factor has to be considered to be 6 times more important before any 1 study area is found to be better than another. The Cloquet Valley study area ranked best most often (after weightings), followed by the Nemadji study area and the Fond du Lac study area.

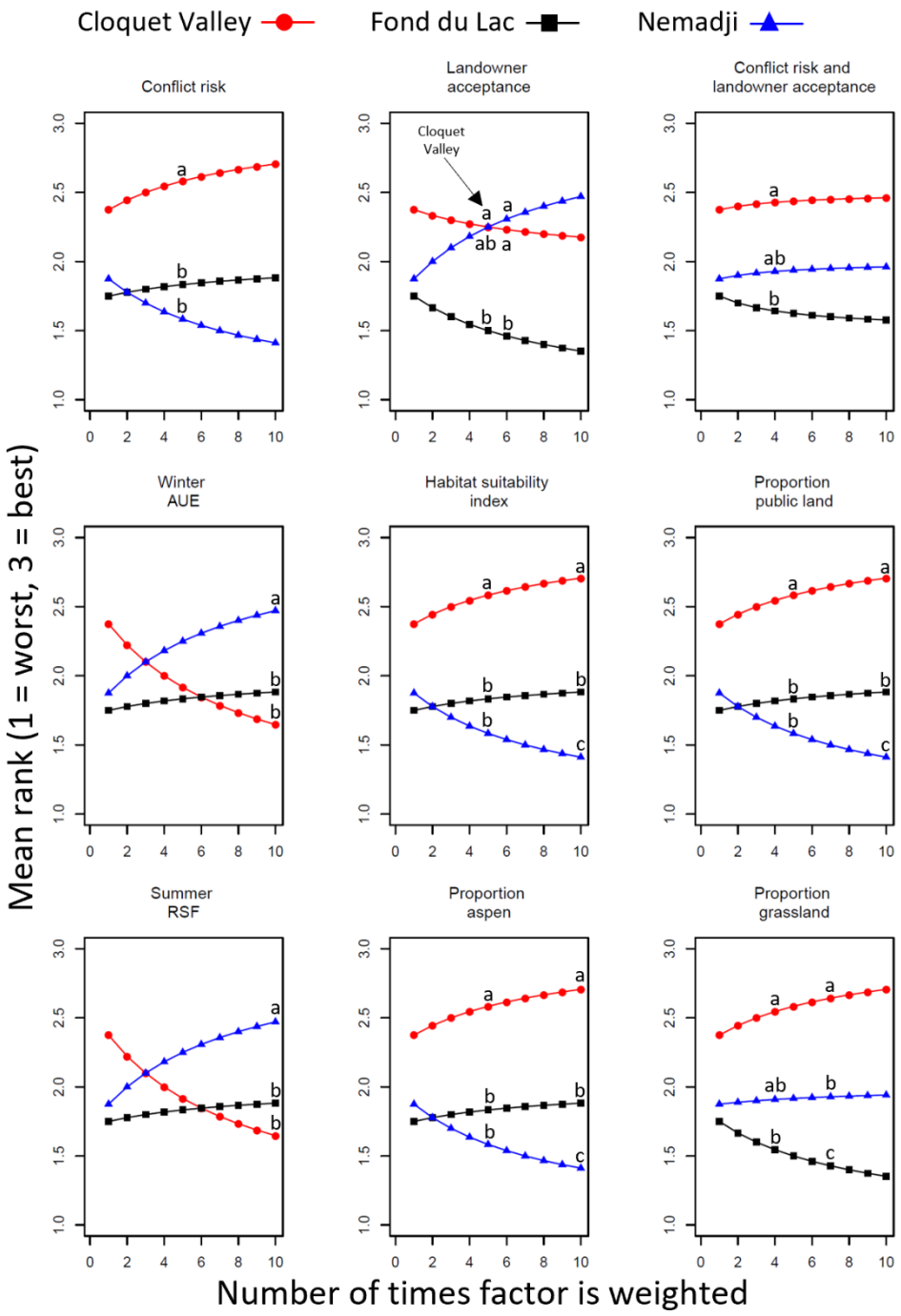

Figure S-10. Mean rank of 3 northeastern Minnesota study areas after weighting factors between 1 (even weights) to 10 (factor counted 10 times). Plot titles indicate weighted factor(s). Letters a, b, and c within plots are first instances of statistically significant pairwise differences that continue to be significant at greater weights. For example, the Cloquet Valley rank was first statistically greatest at conflict risk weight = 5 and continued to be greater at ranks ≥ 5. There were 2 sets of differences for panels that have >1 set of letters. AUE = animal use equivalence. RSF = resource selection function.

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Introduction

Elk (*Cervus canadensis*) historically ranged over most of North America and numbered in the millions, but their numbers declined with overexploitation and habitat loss following European colonization (Murie 1951). Remnant populations in western North America became sources for restorations, and at least 24 elk restorations occurred in eastern North America (Popp et al. 2014). Restoration success varied but has improved (Popp et al. 2014) along with maturation of restoration science (Seddon et al. 2007, Armstrong and Seddon 2008).

Multiple factors influence the success of animal restorations, including the source population (wild or captive), number of animals released, genetics, and competition (Fischer and Lindenmayer 2000). Releasing animals into suitable habitat also influences success (Armstrong and Seddon 2008), as it provides cover from predators and weather, and forage. In eastern North America, winter elk forage is deciduous shrub and tree current year growth (twigs; Jenkins et al. 2007). In an Ontario snow-tracking study, elk selected quaking aspen (*Populus tremuloides*; hereafter aspen) as forage and aspen was the most abundant winter diet item (16% of forage species at feeding stations; Jenkins et al. 2007). Sugar maple (*Acer saccharum*) was also important (11% of forage species), but elk did not select it consistently. Other prominent winter forage species were choke cherry (*Prunus virginiana*), willow (*Salix* spp.), beaked hazel (*Corylus cornuta*), and roundleaf dogwood (*Cornus rugosa*), but elk rarely consumed coniferous species and almost never cratered (excavated snow) to consume grass (Jenkins et al. 2007). The elk diet is different in summer, consisting of forbs, grasses, and deciduous shrub and tree leaves in eastern North America (Schneider et al. 2006, Lupardus et al. 2011). Pellet analyses showed that forbs, grasses, ferns, and legumes were 85% of the elk diet in summer in Tennessee (Lupardus et al. 2011) while >84% was forbs, grasses, and deciduous leaves in Kentucky (Schneider et al. 2006). We did not find diet studies from wild elk in eastern North America located closer to Minnesota.

Forage availability is assessed by field studies that estimate forage biomass. Because it is difficult to measure the mass of shrubs and trees in an area large enough to characterize natural heterogeneity, however, allometric equations estimate biomass using diameter measurements from the main stem of a shrub or tree (at breast height for larger stems and 15 cm for smaller stems). Equations are from species-specific regressions that correlate stem diameter with biomass after harvesting, drying, and massing above ground biomass (Jenkins et al. 2004). In addition to equations for total above ground biomass (for the entire tree or shrub), studies calculate equations for leaves (Smith and Brand 1983, Perala and Alban 1993) and twigs (Grigal et al. 1976). Forage estimates are linked to GIS landcover types, resulting in maps that estimate forage across broad areas (Anderson et al. 2005*a*, Coe et al. 2011).

Maps of broad-scale forage are used to calculate resource selection functions and estimates of how many animals can be supported in an area. Resource selection functions quantify the probability of an animal using 1 area instead of another area by combining data about animal space use (radio telemetry and GPS collar location data) with habitat data (Anderson et al. 2005*b*). Once calculated, these functions predict areas animals will use disproportionately (Anderson et al. 2005*a*, Coe et al. 2011). Estimates of how many animals an area can support

combine forage and energetics data (Kuzyk and Hudson 2007). Feeding trial studies, for example, reveal how much forage elk require to maintain body condition (Christianson and Creel 2009). This information enables calculations of the number of animals supported by available forage, termed animal use equivalence (AUE; Kuzyk and Hudson 2007).

Another common method for assessing habitat suitability is developing habitat suitability indices. Such indices assessed feasibility of restoring elk in many locations, including Arkansas, New York, North Carolina, and Ohio (Didier and Porter 1999, Telesco et al. 2007, Karns et al. 2015, Williams et al. 2015). Habitat suitability indices assign scores to GIS landcover types that range from 0 (unsuitable) to 1 (highly suitable). Grassland, for example, receives a high score for summer elk forage while coniferous forest receives a low score. Habitat suitability indices also assign scores to landcover maps related to human land-use. Road surfaces, for example, are unsuitable due to elk-vehicle collisions. Once landcover maps are scored, a moving window quantifies suitability. Moving windows calculate suitability in the surrounding area for each point on a map. The value of each point on the resulting moving window map represents that location and the area around it, thereby reflecting the fact that while a given point may be good or bad, the suitability of that location is related to its surroundings. This makes sense because elk use big areas, so the quality of a given location is related to both the location and its surroundings. A location in a small gravel pit, for example, is poor habitat. After applying a moving window, however, that location scores higher when surrounded by good habitat. Conversely, a small island with good habitat scores poorly when surrounded by a big lake (open water is poor elk habitat). Moving window size approximates areas elk typically use (home range, 16 km^2; Van Deelen et al. 1997; Didier and Porter 1999; O'Neil and Bump 2014).

In addition to biological considerations such as habitat suitability, public support is important when restoring wildlife as restorations are more successful when people accept restored species (Fischer and Lindenmayer 2000). A common way to assess acceptance is with questionnaires (Walberg et al. 2017). Researchers score questionnaire responses on a scale, with scores corresponding with acceptance (Schroeder et al. 2018). For example, questionnaires are scored from 1 to 7, with 1 equaling low support, 4 equaling a neutral position (not in opposed or supportive), and 7 indicating high support (Walberg et al. 2019). Mapping scores facilitates assessment of where social acceptance is greater and where it is lower (Behr et al. 2017).

Even when public support is strong before restoration, it erodes when human-wildlife conflicts occur afterwards, making it important to assess conflict risk. For elk, multiple factors reduce public support (Hegel et al. 2009, Walter et al. 2010). Elk select road right of ways with high amounts of forage (grasses and forbs; Anderson et al. 2005*b*), which likely increases risk of vehicle collisions. Elk are costly to producers and agencies that institute compensation programs when they damage fences, and depredate row crops, hay bales, grain, and silage (Hegel et al. 2009, Walter et al. 2010, MNDNR 2017). Disease transmission with domestic livestock is another concern for producers. Accordingly, management strategies minimize elk-livestock contact at livestock feedlots (Byrne 1989, MNDNR 2017), which are open land (without maintained vegetation) and buildings where producers hold animals for feeding (pastures are not

feedlots but the 2 often co-occur; MPCA 2007). Assessing conflict risk with habitat suitability and social acceptance will improve understanding of where elk restoration will be successful.

This study examines the feasibility of restoring elk to northeastern Minnesota. Elk once occupied most of Minnesota but were functionally extirpated by the early 1900s (MNDNR 2017; Figure 1). There are currently 3 groups of elk in northwestern Minnesota. The state manages them at low levels by statute[2] as elk have damaged fences and depredated agricultural crops. This state statute does not apply to northeastern Minnesota, where the likelihood of human-elk conflict is lower. Along with a companion study that focused specifically on social acceptance (Walberg et al. 2019), this study provides information for determining where elk restoration will be successful in northeastern Minnesota, should it occur. It assesses habitat suitability, social acceptance, and human-elk conflict.

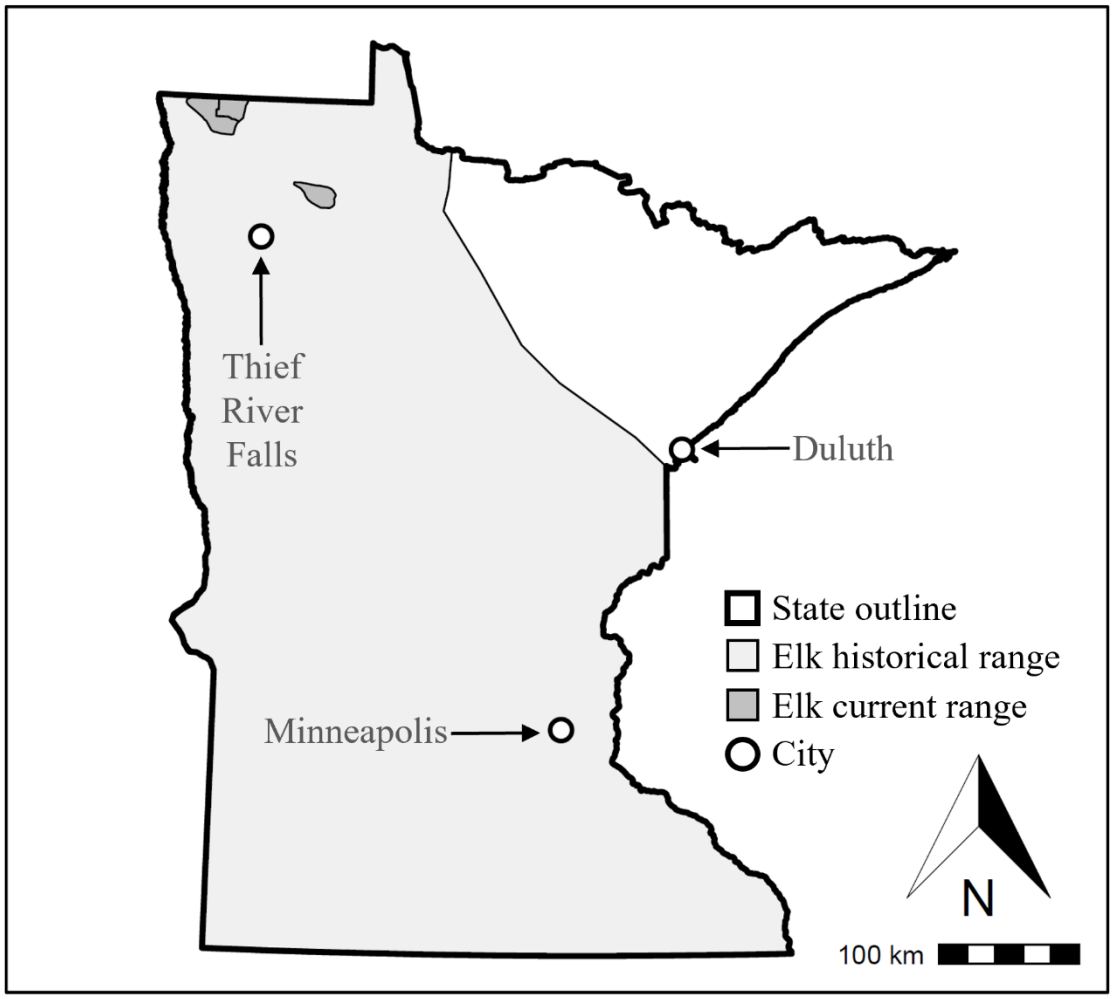

Figure 1. Historical and current elk range in Minnesota. Three cities are included to serve as references.

[2] Minnesota Statute 97B.516 does not allow for an increase in elk population size in Kittson, Roseau, Marshall, or Beltrami Counties unless the commissioner of agriculture verifies that crop and fence damages paid under section 3.7371 and attributed to the herd have not increased for at least two years.

Methods

Study area

We studied habitat suitability social support for elk on and near 3 study areas in northeastern Minnesota (Figure 2). Study areas were comprised mostly of public land (Table 1) and had low road densities (mean = 0.96 km/km^2, *SD* = 0.19 km/km^2, *N* = 3) that are suitable for elk (< 2 km/km^2; Lyon 1983; Beazley et al. 2004). The area was in the northern lakes and forests ecoregion (Level III Region 50), with often rolling topography, relatively nutrient-poor glacial soils, and scattered lakes and rivers (Omernik and Griffith 2014). Forests were coniferous and northern hardwood types, and forest stands were often mixed. Maps we created (described below) were for the 3 study areas and the surrounding 20 km (corresponding to elk dispersal distance in Ontario, near the Minnesota border; Ryckman et al. 2010).

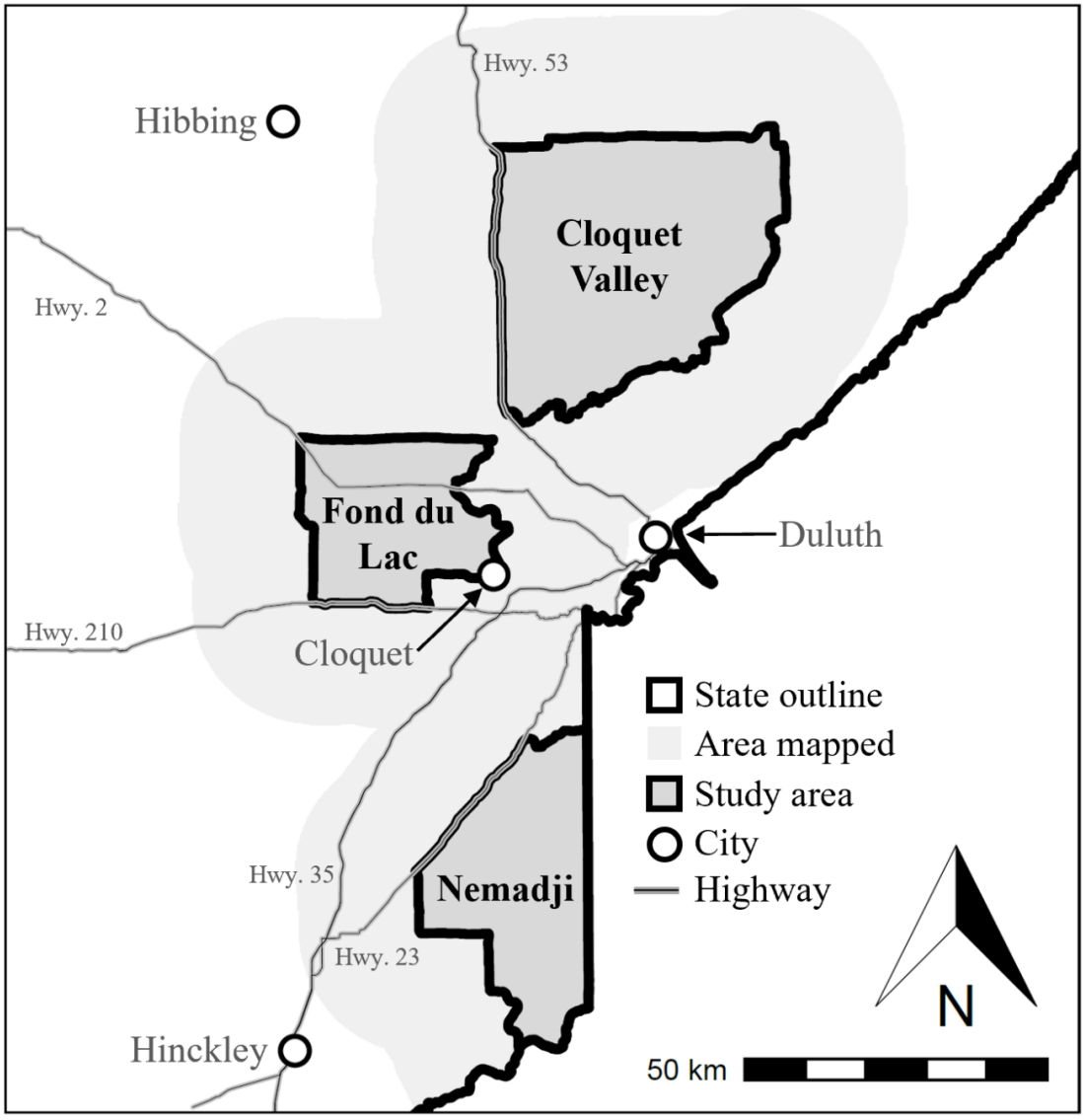

Figure 2. Study areas in northeastern Minnesota where we studied the feasibility of restoring elk. Larger cities and highways are included to serve as references.

Table 1. Ownership areas and proportions on 3 study areas (but not surroundings) in northeastern Minnesota.

	Area in each ownership classification (km^2) [a]								
Study area	Federal	Tribal	State [b]	County [b]	Private	Private industrial	Total	Total public (proportion)	Total private (proportion)
Cloquet Valley	153	0	1162	5 [c]	316	128	1764	1320 (0.75)	444 (0.25)
Fond du Lac	17	69	379	8	272	21	766	473 (0.62)	293 (0.38)
Nemadji	0	1	579	2	372	8	963	582 (0.60)	380 (0.40)

[a] Private non-industrial and private conservancy classifications not included; each was 0 km^2.

[b] State totals appear large and county totals appear small as many properties managed by counties are state-owned (tax-forfeited).

[c] Includes 2 km^2 of classification: other public.

Forage estimation

Field plots

We measured trees, shrubs, and understory vegetation at sites distributed throughout the 3 study areas between June 14 and August 8, 2017 (hereafter, season 1) and June 6 and August 8, 2018 (season 2). Sampling occurred on public land during season 1 and on private land during season 2. During season 1 we randomly distributed points on roads that abutted public land. We then randomly distributed 1 point in each vegetated landcover type (Rampi et al. 2016) that was within 50 to 500 m of the road point (to improve logistics) and randomly selected cover type points to sample (with periodic adjustments for even sampling of cover types). During season 2 we randomly distributed 1 point within each cover type that was within 50 to 500 m of a road that abutted private properties and randomly selected cover type points to sample. We distributed sampling points in R (R Core Team 2019) and ArcMap 10.5 (ESRI 2018).

To achieve sampling that was even through space (with respect to roads) and time (with respect to field season duration), we selected road points or properties using a stratified-random design, whereby strata were study area and rectangular quadrants (equal in area) overlaid on each study area in a GIS. We sampled study areas and quadrants systematically. For example, we selected the Nemadji study area and then selected road points or properties within quadrant 1. The next day we sampled Nemadji quadrant 2, and so forth until we sampled all 4 Nemadji quadrants. We repeated the same process in the other study areas before returning to the Nemadji study area.

Before season 2 we selected private properties to sample from the population of landowners who responded to a mail questionnaire (Walberg et al. 2019). We used a stratified random approach to select private properties to sample, whereby strata were study area and rectangular quadrant. We randomly selected landowners from each study area and contacted them by email ($N = 45$) and phone ($N = 41$), resulting in access from 47 landowners to 66 private properties (Cloquet Valley study area, $N = 16$; Fond du Lac study area, $N = 28$; Nemadji study area, $N = 22$). We then randomly selected properties from study area quadrants that we sampled systematically. During season 2 we also stratified sites for sampling in aspen regeneration on public lands by randomly selecting county-managed forest stands where harvest occurred within the last 10 years (M.P. Westphal, Carlton County; D. Ryan, US Forest Service; J. Kelash, Pine County; and B. Hakala, Saint Louis County; *Unpublished data*).

We established a circular plot centered on each cover type point (hereafter referred to as a field plot). Each field plot comprised nested circles within which we sampled trees, shrubs, and herbaceous vegetation. The largest circle was 401 m^2 (11.3 m radius). In this circle we measured diameter at breast height (DBH; 1.4 m) of trees > 10 cm DBH with a diameter tape. Three medium circles (25 m^2 plots; 2.8 m radius) radiated 5.5 m from the plot center at azimuths of 30°, 150°, and 270°. In these circles we used a stepped diameter gauge (*Sensu* Paul et al. 2017) to count trees and shrubs that were 2.54 cm to 10 cm DBH. We centered a small circle (10 m^2; 1.8 m radius) within each medium circle. In small circles we used a stepped diameter gauge to count trees and shrubs that were ≥ 15 cm tall and < 2.54 cm diameter (measured at 15 cm height,

D15). Counts for stems < 2.54 cm were in 0.5 cm increments (e.g., number of stems between 0.5 cm and 1 cm) while counts for stems 2.54 cm to 10 cm were in 1 cm increments.

In addition to measuring and counting trees and shrubs at each field plot, we collected ground cover vegetation from 10 1.5 m^2 rectangular (150 cm x 10 cm) quadrats. One quadrat was at the center of each plot, 1 was at the center of each medium circle, and 1 was at each 60° increment (starting at an azimuth of 30°) along the border of the large circle. We clipped (from 1.5 cm above the ground) woody vegetation that was < 15 cm tall and herbaceous vegetation (all heights) within each quadrat. We classified clipped vegetation as: grasses, forbs, sedges, rushes, ferns, and woody vegetation. We then dried clipped vegetation at 40 °C (Isotemp Gravity and Convection Oven; Fisher Scientific, Pittsburgh, Pennsylvania) for 48 h and recorded mass for each group. Other data collected at plots included canopy cover (using a densiometer), aspect, slope, and visually estimated height and percent ground cover at vegetation quadrats.

Right of way plots

We measured forage adjacent to paved and gravel roads, railroad tracks, and pipelines (hereafter, right of ways) in season 2. There were 4 road classes sampled: county, federal, state, and township. Pipelines were underground and the area above them was open (managed to remove trees and shrubs) with a lightly maintained 2-track service road. Areas adjacent to roads and railroads were also open.

We used a random-stratified approach to select right of way locations for sampling, where strata were study area and road class (for sampling road right of ways). We selected road right of way locations by plotting points randomly on roads (MNDOT 2017). We randomly selected railroad (MNDOT 2015) and pipeline locations (traced in Google Earth) that intersected roads (to ensure access) and randomly selected a distance 50 to 500 m from the intersection for sampling. As each right of way feature (e.g., road) was bordered by 2 open areas (1 on either side), we randomly selected a side of the right of way for measuring forage. We supplemented road right of way data by sampling right of ways that abutted private properties we accessed.

At each right of way sampling site, we established a 200 m^2 rectangular plot (hereafter, right of way plot). We measured the distance between the edge of the road, pipeline service road 2-track, and railroad and the nearest tree line or shrub line. This measurement was the width side of the plot. The length side of the plot paralleled the road or railroad. We calculated the plot length side by dividing 200 by the width side measurement. We used a plot width of 30 m where a tree line or shrub line was > 30 m from the road or railroad edge. Once we established a right of way plot, we clipped ground cover vegetation from 5 quadrats: 1 placed at the plot center and 1 placed at each plot corner. This resulted sampling intensity that was similar to field plots (1 quadrat/40 m^2). Quadrat dimension, vegetation classifications, and drying methods were the same as described for field plots. In addition to clipping vegetation at right of way plots, we measured the distance between the tree lines or shrub lines that bordered each side of the right of way and the width of the railroad bed or road using a laser range finder. This resulted in a total right of way width (for both sides of the right of way) including the railroad bed and road surface.

Forage estimates

We estimated forage available to elk at each field plot during 2 periods: leaf-on (hereafter, summer) and leaf-off (hereafter, winter). Summer forage at each field plot was the sum of biomass from leaves, forbs, and grasses, as these are the most frequently consumed items by elk in eastern North America during summer (Schneider et al. 2006, Lupardus et al. 2011). To estimate forage from shrubs and sapling leaves, we summed woody stem counts from medium and small circles at each field plot (for each diameter class separately) and used allometric equations to estimate leaf biomass (Smith and Brand 1983, Perala and Alban 1993). All forage estimates were converted to kg/m^2. We estimated forb and grass forage by summing the masses of forbs and grasses that we collected, dried, and massed at each field plot.

As elk in eastern North America forage on deciduous shrub and tree current year growth (twigs) during winter (Jenkins et al. 2007), we estimated current year growth using allometric equations like those used to estimate leaf biomass. Instead of estimating leaf biomass (equations unavailable for most species), however, we estimated total above ground biomass (Smith and Brand 1983, Perala and Alban 1993) at each field plot and estimated current year growth as the product of biomass and proportion of biomass that is current year growth in Minnesota (0.07; (Ohmann et al. 1974, Ohmann et al. 1976).

We estimated forage biomass for shrubs and trees that were ≤ 2.54 cm in diameter (D15) as this diameter corresponds with mean height at which elk forage (1.5 m; Rounds 2006; Gehring et al. 2008; VanderSchaaf 2013). It strikes a balance in estimating available forage by excluding some forage that is within reach of elk (from taller trees and shrubs with low-hanging crowns) while including some forage that is out of reach to them (from ≤ 2.54 D15 trees and shrubs with crowns extending above the reach of elk; VanderSchaaf 2013). We estimated summer forage at right of ways by summing forb and grass biomass at each right of way plot.

Forage comparisons

We used analysis of variance (ANOVA) to determine if forage differed by study area, cover type, and ownership (public or private; stats package in R). Forage was the dependent variable in separate analyses for summer and winter. We used ANOVA to test for differences in summer forge between road right of way types (e.g., county roads vs. state roads) and forage between all right of way types and followed significant ANOVAs with Tukey tests. We transformed forage biomass by the square root for all statistical tests to meet model assumptions. We set $\alpha = 0.05$ and assessed collinearity using the variance inflation factor (for all statistical tests hereafter).

Forage maps

We used random forest analysis to model summer and winter forage at field plots (Breiman 2001, Cutler et al. 2007). Random forest fits a large number of regression trees (a forest), with each regression tree constructed by recursive partitioning of data into smaller groups at binary splits based on a single predictor variable that maximizes homogeneity of the resulting groups (minimizes residual sum of squares). Whereas classic regression tree analysis uses all data to construct a tree, random forest analysis constructs each tree with a random subset of predictors and then combines the results from all trees to yield predictions that are robust to outliers or

small changes in data and unbiased out-of-bag (OOB) error rates that make dividing data into training and test sets and cross-validation unnecessary (Prasad et al. 2006).

Random forest models result in predictions of the dependent variable that are means from the ensemble of multiple trees. It also calculates measures of accuracy and variable importance based on mean squared error (MSE) of OOB data (Liaw and Wiener 2002). A pseudo-R^2 ($1 - MSE_{OOB} / \sigma^2_y$) summarizes model accuracy. The importance of each predictor variable is computed by comparing prediction error (standardized MSE) on the OOB portion of data with prediction error after permuting predictor variable values (Liaw and Wiener 2002).

Random forest is frequently used in geospatial modeling (Rodriguez-Galiano et al. 2012, Karlson et al. 2015) as it models nonlinear relationships and interactions without error distribution assumptions (e.g., normality; Cutler et al. 2007), is robust to missing data (Rodriguez-Galiano et al. 2012), and does not overfit (Breiman 2001). Results from random forest models are often more accurate than those from other methods, including regression trees and linear models (Prasad et al. 2006, Chen et al. 2017).

To estimate potential forage biomass at our field sites, we implemented random forest analysis in R (randomForest package; Liaw and Wiener 2002). Analysis included biologically relevant predictor variables that we extracted from 15 m resolution GIS raster maps spanning the three study areas (Table 2). Before analysis, we screened and eliminated correlated independent variables (Millard and Richardson 2015; Spearman correlation coefficient $|r_s| > 0.5$; stats package in R), including slope, aspect, precipitation, and temperature. We kept only the variable that resulted in greater predictive accuracy (assessed using pseudo-R^2) when variables were correlated (Gustafson et al. 2003). Each random forest model predicted leaf or total biomass (square root transformed) by growing 1,000 regression trees, each using 33% of predictor variables (Liaw and Wiener 2002).

Table 2. Independent variables used to model elk forage in northeastern Minnesota.

Independent variable	Description
Cumulative topographic index	Wetness index based on topography
Elevation	Lidar based elevation (bare earth)
Enhanced vegetation index for spring	Landsat 8 based vegetation index for April 2018
Enhanced vegetation index for summer	Landsat 8 based vegetation index for August 2018
Height	Lidar based height of above ground for any object
Insolation	Lidar based solar radiation (WH/m^2)
Normalized difference moisture index for spring	Landsat 8 based moisture index for April 2018
Normalized difference moisture index for summer	Landsat 8 based moisture index for August 2018
Ownership	Private or public ownership
Phenology	Number of days into summer when plot was sampled
Study area	Cloquet, Fond du Lac, and Nemadji study areas
Years since disturbance	Landsat based number of years since harvest, fire, and other disturbance

Using random forest model results and corresponding GIS maps, we predicted potential summer and winter elk forage across the 3 study areas and the surrounding 20 km (raster package; Hijmans 2019). Forage estimates were not spatially autocorrelated (Moran's I test, $P > 0.25$; spdep package in R; Millard and Richardson 2015, Bivand and Wong 2018).

We included right of way forage estimates when estimating summer forage. To do so, we estimated forb and grass forage biomass at right of ways distributed throughout the study areas by extrapolating measurements made in the field. For each right of way type (e.g., county highway) we calculated mean forb and grass biomass and mean right of way width (distance between shrub lines and tree lines that bordered the right of way). To extrapolate to the study area, we buffered right of ways (linear features in GIS) with mean right of way widths and deleted corresponding mean road widths. We rasterized the resulting map and assigned mean biomass to each cell. The resulting map depicted forage bordering right of ways.

When extrapolating, we used grand mean biomass and right of way width for road classes we did not sample (2 classes: other and municipal). We used forage estimates from pipelines to estimate forage at powerline right of ways (Minnesota Geospatial Information Office 2016), as we did not sample powerline right of ways. Powerline right of ways were only from high voltage (69 to 500 kilovolt) lines that were managed similarly to pipelines (maintained to be open), had similar widths (measured using Google Earth), and similar biomass characteristics (qualitatively assessed using Google Earth).

Animal unit equivalence

We used forage estimates to estimate animal use equivalence (Kuzyk and Hudson 2007). After predicting potential forage using random forest analysis, we summed forage using a 16 km^2; circular moving window. Each cell in resulting maps depicted available forage in the surrounding 16 km^2. Using forage maps, we calculated animal use equivalence (AUE) for elk as:

$$AUE = \frac{F \times C}{S \times M \times D};$$

where F was potential seasonal (winter or summer) forage available in the surrounding 16 km^2, S was dry forage (expressed as % elk body mass) required to sustain an elk of mass M for 1 day during a season lasting D days, and C was a correction factor reflecting how much forage elk consume in their use areas. AUE was for cow elk with a mass of 250 kg (median cow elk mass in Michigan; Bender et al. 2006), consuming 2.1% of body mass per day during a winter (Christianson and Creel 2009) lasting 200 days, and 2.2% of body mass per day during a summer (Kuzyk and Hudson 2007) lasting 165 days. To account for the presence of shrubs and trees not consumed within their use areas, we assumed elk consume the same proportion of available forage as do moose (*Alces alces*; 0.03 of available forage; Peek et al. 1976, Edenius et al. 2002). Each cell in resulting maps estimate the number of elk supported by the surrounding 16 km^2.

For AUE (and other maps we developed) we report the mean and standard deviation (*SD*) of raster map cell values in each study area, as well as the relative differences between study area means. We did not conduct statistical analyses (e.g., ANOVA) as map values are from a large number of cells (≥ 3,402,931), making statistical test *P*-values uninformative (Lin et al. 2013).

Biological carrying capacity

We used winter AUE to estimate carrying capacity for elk in each study area. It made sense to use AUE from winter as it is the limiting season for many animals at high latitudes and is when elk aerial surveys occur. We calculated carrying capacity (K_w) using:

$$Kw = \frac{AUE_w \times A}{16};$$

Where AUE_w was study area specific mean winter animal use equivalence and A was the area of each study area (km^2). For a range of potential K_w we made additional calculations after substituting AUE_w with $AUE_w \pm 1.96 \times SD$. These estimates likely underestimate biological carrying capacity as we assumed when calculating AUE that elk consume a small proportion of available forage (as observed for moose; Peek et al. 1976, Edenius et al. 2002). They also do not account for cultural carrying capacity, which may differ from biological carrying capacity (Minnis and Peyton 1995).

Habitat suitability

We used a habitat suitability index developed in Wisconsin (Gilbert et al. 2010) to map habitat suitability. The habitat suitability index used landcover types to estimate spring forage, winter forage, winter cover, and compatibility with people (hereafter, social suitability). It combined these indices to create a map of overall suitability.

Following the methods of Gilbert et al. (2010) we developed habitat suitability index maps by scoring landcover classes (Rampi et al. 2016) from 0 to 1 (0 = unsuitable and 1 = highly suitable) for spring food, winter food, and winter cover (Table 3). We used the same scores as Gilbert et al. (2010). This resulted in 1 map each for spring food, winter food, and winter cover.

Table 3. Suitability index scores for landcover classes representing spring food, winter food, and winter cover for elk. Index scores based on Gilbert et al. (2010).

Landcover class	Spring food [a]	Winter food [a]	Winter cover [a]
Conifer	0.50	0.70	0.50
Deciduous	0.70	0.90	0.30
Emergent wetland	0.70	0.00	0.00
Forested and shrub wetland [b]	0.43	0.27	0.53
Grassland	0.70	0.30	0.00
Mixed forest	0.30	0.50	0.30

[a] Extraction, hay field, row crop, impervious, and water were 0.

[b] Mean of values for lowland shrub, forested wetland, and shrub from Gilbert et al. (2010).

Additional maps assigned social suitability according to land ownership (from 0 to 1; Table 4) and as a negative function of road density (Gilbert et al. 2010, MNDOT 2017). After developing each map, we combined them to create a map of overall suitability. The overall suitability map reflected the geometric mean of all map scores, but with a suitability score of 0 assigned to row crops, hay/pasture fields, and urban areas. After scoring each raster cell in each map, we applied a circular moving window to calculate mean suitability within the surrounding 16 km^2.

Table 4. Suitability index scores for landowner classes. Based on Gilbert et al. (2010).

Owner	Suitability
County	0.80
Federal	0.80
Other public [a]	1.00
Private	0.00
Private (non-industrial)	0.50
Private conservancy [b]	1.00
Private industrial	0.50
State	1.00
Tribal	1.00

[a] Used value from Gilbert et al. (2010) for parks, trails, and riverways.
[b] Used value from Gilbert et al. (2010) for Scenic Natural Areas.

Our methods were similar to those from the Wisconsin habitat suitability index, but while the Wisconsin habitat suitability index used a 100 km^2 moving window to estimate statewide suitability, we used 16 km^2 to be consistent with other habitat maps we developed and other elk habitat suitability studies (Van Deelen et al. 1997, Didier and Porter 1999, Karns et al. 2015).

Resource selection

We used a resource selection function developed from elk radio telemetry locations collected during summer in Wisconsin (large extent function; Anderson et al. 2005*b*) to map the relative probability elk would select areas in and near our study areas. The resource selection function predicted the relative likelihood of home range selection by elk (second order selection; Johnson 1980). It is possible that these resource selection functions will predict relative elk habitat selection well on our study areas as they originate from the same ecoregion (Level III Region 50; Omernik and Griffith 2014).

Following the methods of Anderson et al. (2005*b*), we used field plot data to calculate mean biomass of forbs and grasses, woody browse, and sedges in each landcover type (e.g., conifer; Rampi et al. 2016). We then assigned these biomass values to each landcover type raster cell and used a circular moving window to calculate mean biomass in the surrounding 0.3 km^2 (300 m radius). Two other maps contained the distance from each map raster cell to the nearest road (MNDOT 2017) and wolf territories (data from packs monitored during 2015 to 2018; Erb et al. 2017, M. Swingen, 1854 Treaty Authority; *Unpublished data*). We used biomass, road distance, and wolf distance to calculate selection scores using parameters from Anderson et al. (2005*b*). We then classified scores using quartiles. Resulting scores ranged from 1 to 4, reflecting increasing probability of selection.

The distance from nearest wolf territory was influential for estimating elk resource selection (Anderson et al. 2005*b*), but we did not know the location of some wolf pack territories, including all recent territories on the Nemadji study area. To account for missing territories, we developed a second resource selection function map after setting the influence of wolf territories to 0. The resulting map reflected selection scores (1 to 4) without the influence of wolves.

Aspen, grassland, and public land

We used a moving window (16 km^2) to calculate aspen, grassland, and public land densities in a GIS. Aspen was from a forest inventory layer for public land (C. Beal, United States Forest Service; *Unpublished data*). Grassland was from the landcover data used for other analyses (Rampi et al. 2016; excluded hay/pasture landcover class). Land ownership data combined multiple landowner databases (D. Wilson, University of Minnesota; *Unpublished data*).

Social acceptance

We used data from 2 surveys to map social acceptance for elk across the 3 study areas: 1 of landowners and 1 of local residents. These data, further details, and additional analyses are presented in a companion report by Walberg et al. (2019).

Landowners

Landowners owned ≥ 4 ha of land located ≤ 8 km of the 3 study areas. It made sense to include an analysis that focused on landowners as (all else being equal) elk are more likely to use a large property than a small property and elk are more likely to be restored to areas with large tracts of land than to areas with smaller tracts. Additionally, producers are often landowners and are more likely to experience property damage and concerns about livestock-elk disease transmission.

From the population of landowners in northeastern Minnesota, we used a random-stratified approach to select 4,500 landowners, where the stratum was hectares owned (2 levels: 4 to 16 ha and >16 ha). We mailed selected landowners a questionnaire (up to 2 additional questionnaires to nonrespondents). The questionnaire asked landowners about their attitudes toward elk restoration in the area. We measured landowner attitudes toward elk restoration using 2,550 returned questionnaires scored using a scale ranging from very unfavorable (1) to very favorable (7). We included 35 additional surveys from respondents of the local resident survey (see below) who owned ≥ 4 ha of land located ≤ 8 km from the study areas, bringing our sample to 2,585 surveys.

We determined if landowner attitudes were more likely to be favorable on any of the 3 study areas by comparing attitudes of landowners who owned property inside the boundaries of the 3 study areas. While this analysis did not include landowners from outside the study area boundaries, mapping of attitudes (see below) and the companion report by Walberg et al. (2019) did. Focusing on landowners with property within the study area boundaries made sense as restored elk will affect these landowners before others. We assigned landowner attitude scores to points at the center of properties (polygon representing land ownership) they owned and randomly selected a property when a single landowner owned > 1 property. Residuals from linear models of acceptance scores were not normally distributed so we categorized scores ≤ 3 as unfavorable to elk restoration (0) and scores ≥ 5 as favorable to elk restoration (1), and tested for different attitude scores in each study area using logistic regression and Wald tests for pairwise comparisons (stats package in R; acceptance scores = 4 were not used for analysis).

To better understand how attitudes were distributed in space, we mapped mean attitude scores. This mapping process included questionnaire responses from landowners with land inside and ≤ 8 km away from the study area boundaries to provide a better understanding of attitudes in the broad area where elk populations are likely to expand if restored. It used a circular moving

window with an area equaling 4 townships (372 km^2, 10.9 km radius). This window was larger than others we used to ensure > 20 respondents in most calculations. It created a map surface that filled in intervening areas with opinions from multiple landowners. Smaller moving windows we developed resulted in what amounted to a less informative point map, with isolated 15×15 m raster cells representing a single landowner's attitude. For example, the 16 km^2 window's radius is 2.3 km but landowner properties were usually > 2.3 km apart, resulting in isolated raster cells (1 for each land parcel) separated by large areas without acceptance estimates.

Local residents

In addition to considering landowner support, we examined data from a local resident survey (details in Walberg et al. 2019). We selected 4,000 local residents using a random-stratified approach, with a geographic stratum containing 4 levels: (1) St. Louis County south of the St. Louis River; (2) Carlton County; (3) Pine County north of Minnesota Highway 48; and (4) Duluth and surrounding suburbs. These areas matched census blocks corresponding to county boundaries and major landmarks (e.g., roads).

As we did for landowners, we determined if attitudes were more likely to be favorable on any of the 3 study areas by comparing attitudes of members of the general public who had mailing addresses within the boundaries of the 3 study areas. As was the case for the landowner statistical analysis, we did not include residents from outside the study area boundaries, but mapping of attitudes (see below) and the companion report by Walberg et al. (2019) did. As above, we categorized scores ≤ 3 as unfavorable to elk restoration (0) and scores ≥ 5 as favorable (1), and tested for different attitude scores by study area using logistic regression and Wald tests for pairwise comparisons (stats package in R; acceptance scores = 4 were not used for analysis).

To better understand how local resident attitudes were distributed in space, we mapped mean attitude scores using methods described above for landowners (circular moving window the size of 4 townships). This mapping process included local resident respondents with addresses inside and outside of the 3 study areas, bringing our sample size to 1,521 local resident respondents.

Risk of human-elk conflict

To assess the potential for elk-human conflict we developed a risk map by calculating the proportion of area (16 km^2 moving window) that was row crop and hay/pasture, feedlot, and road surface. Each cell in the resulting map is the proportion of the surrounding 16 km^2 that has potential for conflict should an elk center its activities there. For example, if an elk use area is centered on a cell with conflict risk = 0.15, then 15% of its likely use area poses conflict risk.

Row crop and hay/pasture were from landcover data used in other analyses (Rampi et al. 2016). Road data came from buffering road centerlines with road widths measured for different road classes in the field (MNDOT 2017; see the *Right of way plots* section above). We estimated feedlot area by buffering feedlot locations 0.12 km^2 (median feedlot size). Locations were for cow, horse, and pig feedlots (MPCA 2007) and we added a dataset containing the 4 captive cervid operations within 20 km of the 3 study areas (locations from 2017; Minnesota Board of Animal Health, *unpublished data*). Nearly all (98%) of the 923 feedlots within 20 km of our study areas included open lots and pasture, and 84% had holding areas (MPCA 2007). These are

locations where elk-livestock contact occurs and where elk raid dispersed and stored forage. To estimate feedlot size, we measured 20 randomly selected northeastern Minnesota (within 20 km of study areas) feedlots in Google Earth. Feedlot measurements included grassless areas and adjacent pastures with cow paths.

Winter suitability

We intersected maps to identify areas best suited for elk restoration using maps we developed (described above). We calculated mean: (1) winter AUE; (2) winter forage habitat suitability index; and (3) winter cover habitat suitability index. We then deleted areas with values less than the mean from each map and intersected resulting maps with areas where social acceptance for elk restoration was high (acceptance score ≥ 5). Resulting map depicted areas where winter conditions were better than mean conditions and restoration was most favorable to landowners.

Ranking study areas

We ranked the suitability of elk restoration for each study area using mean values from maps we developed. We calculated mean values from each study area (e.g., mean winter AUE for the Cloquet Valley study area) and ranked study areas from worst (1) to best (3). Means we ranked were: (1) winter AUE; (2) overall habitat suitability index from Wisconsin; (3) summer resource selection (excluding wolf territories because we lacked recent Nemadji study area data); (4) proportion grassland; (5) proportion aspen; (6) social acceptance (from questionnaire); (7) conflict risk; and (8) proportion public land. The best study areas had greatest means (e.g., mean winter AUE) and highest proportions (e.g., proportion aspen), while the worst study areas had the lowest means and proportions. We compared ranks using a one-way permutation test for ordinal data (Hothorn et al. 2008).

To measure the influence of considering 1 factor to be most important, we weighted ranks of each factor by including records for each factor more than once. For example, we included the set of conflict risk ranks 2 times in our dataset (weight = 2) but included only 1 set of ranks for other factors (e.g., 1 set for winter AUE). We then repeated this after including risk ranks 3 times in our dataset (weight = 3), and so forth until we included 10 sets of risk ranks (but only 1 set from other factors). For each of the 10 weighting iterations, we compared study area ranks using a one-way permutation test for ordinal data (as above). A pairwise permutation post-hoc test (Holm's method) followed significant one-way tests. In addition to weighting the factors above, we weighted conflict and social acceptance together by weighting both factors at the same time for each of the 10 weighting iterations.

Thresholds from other elk studies

We compared forage availability, AUE, and habitat suitability to threshold values from other studies. We calculated the area within each study area that had ≥ the amount summer forage preferred by elk (0.120 kg/m^2 of forage; Wilmshurst et al. 1995) and the area that had ≥ the mean amount of winter forage where elk occur in Wisconsin (Anderson et al. 2005*a*). Winter forage estimates from Wisconsin (0.025 kg/m^2) included grasses (Anderson et al. 2005*a*), while our winter forage estimates did not (as elk rarely crater for grass in winter in eastern North America; Jenkins et al. 2007). When we accounted for this difference by eliminating grass from Wisconsin

estimates (using the proportion of grass on our field plots), adjusted winter forage in Wisconsin was 0.017 kg/m^2.

We calculated the area within each study area with winter AUE ≥ densities reported in Michigan and Wisconsin after multiplying density estimates (elk/km^2) from Michigan and Wisconsin by 16 to make them comparable to our AUE estimates. Elk density is about 7 elk/16 km^2 in Michigan (converted from 0.46 elk/km^2; MIDNR 2019), 5 elk/16 km^2 in Wisconsin's Black River Herd (0.33 elk/km^2 in core area; Stowell et al. 2012, WDNR 2019), and 3 elk/16 km^2 in the Clam Lake Herd (0.20 elk/km^2 in core zone; Stowell et al. 2012, WDNR 2019*b*). Area calculations we made used estimates from Michigan and the Black River Herd as threshold values (elk densities ≥ 7 elk/16 km^2 and 5 elk/16 km^2). Lastly, we calculated the area within each study area with habitat suitability ≥ 0.5. This calculation used the overall suitability score from the Wisconsin model (Gilbert et al. 2010). We selected 0.5 as our threshold as Wisconsin herds occur in areas with suitability index scores ≥ 0.5 (Gilbert et al. 2010, Stowell et al. 2012).

Results

Forage estimation

We sampled 186 field plots, including 63 plots in the Cloquet Valley study area, 69 in the Fond du Lac study area, and 54 in the Nemadji study area. Mean summer forage at field plots was 0.130 kg/m^2 (SD = 0.106, N = 186 plots) and winter forage was 0.017 kg/m^2 (SD = 0.016, N = 186 plots). Winter forage differed by ownership ($F_{1,177}$ = 17.08, P < 0.01) and landcover type ($F_{5,177}$ = 2.65, P = 0.02), but not by study area ($F_{2,177}$ = 1.50, P = 0.23). Public land had more winter forage than private land (Tukey P < 0.05; Figure 3A) and forested shrub wetlands had more winter forage than grasslands (Tukey P < 0.05; Figure 3B). Summer forage differed by landcover type ($F_{5,177}$ = 3.20, P < 0.01), but not by study area ($F_{2,177}$ = 1.16, P = 0.32) and ownership ($F_{1,177}$ = 0.24, P = 0.62). Grasslands had more summer forage than coniferous forests (Tukey P < 0.05) and mixed forests (Tukey P < 0.05; Figure 3C). Two way and 3-way interactions were nonsignificant for winter and summer forage models.

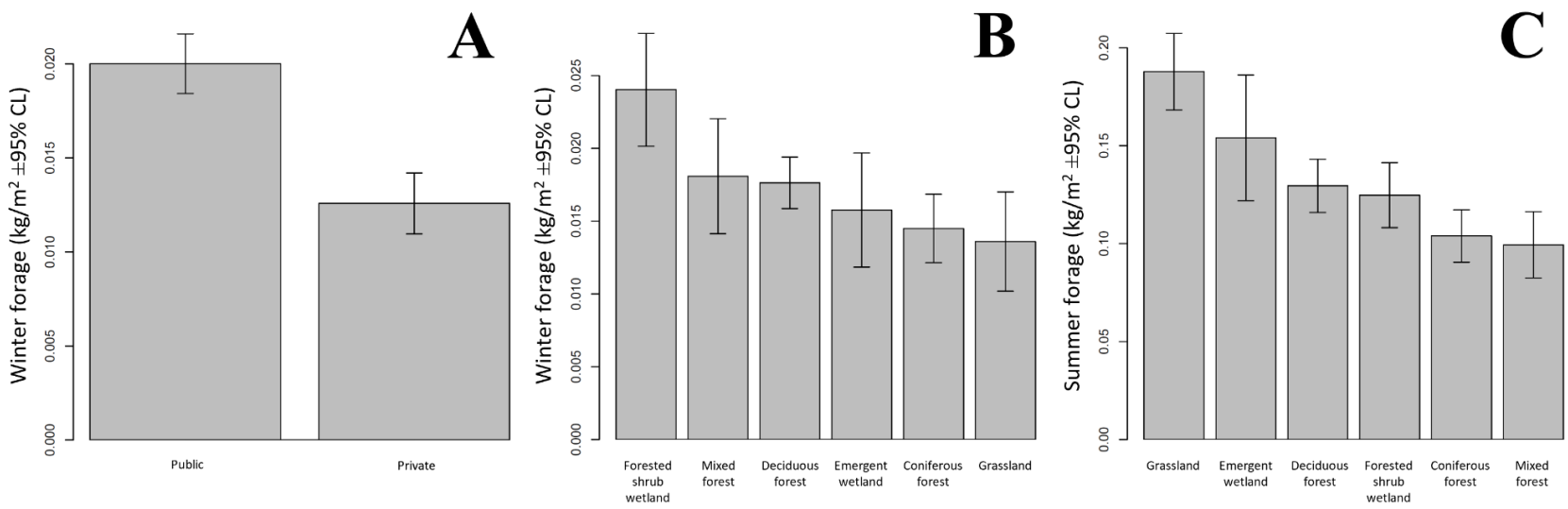

Figure 3. Winter forage on public and private land (A) and by landcover type (B), and summer forage by landcover type (C) in northeastern Minnesota. CL = confidence limits. Each panel is sorted in descending order by mean forage.

The random forest model for potential winter forage was 19% accurate (pseudo-R^2 = 0.19) and the 3 most important variables were phenology, August enhanced vegetation index, and April enhanced vegetation index (Figure 4A). Fifty percent of predictions were within 0.007 kg/m^2 of field observations and 75% were within 0.015 kg/m^2 (Figure 4B).

Summer forage estimates were an order of magnitude greater than winter estimates (Figures 4C). The random forest model for summer forage was 30% accurate and the 3 most important variables for predicting forage were April enhanced vegetation index, phenology, and August normalized difference moisture index. Fifty percent of predictions were within 0.050 kg/m^2 of field observation and 75% were within 0.080 kg/m^2 (Figure 4D).

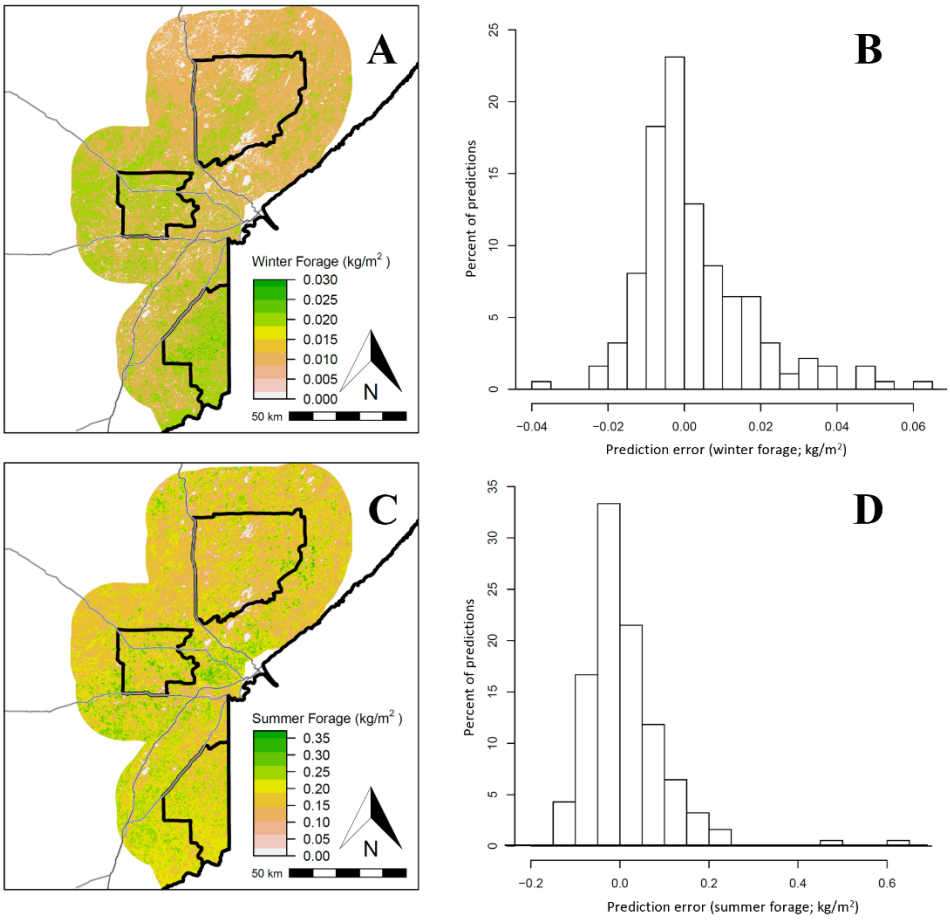

Figure 4. Estimated forage and prediction error (observed forage minus predicted forage) for winter (A and B) and summer (C and D) in northeastern Minnesota during summer 2017 and 2018. Summer forage includes forbs and grasses at right of ways.

We sampled summer forage at 29 right of way plots. Mean forage was 0.136 kg/m^2 (*SD* = 0.117, *N* = 21) along road right of ways, 0.122 kg/m^2 (*SD* = 0.077, *N* = 6) along railroads, and 0.409 kg/m^2 (*SD* = 0.127, *N* = 2) along pipelines (Table 5).

Table 5. Number of right of way plots sampled in northeastern Minnesota in summer 2018.

	Biomass (kg/m^2)		Width (m)		
Right of way type	Mean	*SD*	Mean	*SD*	*N*
All roads	0.136	0.117	44.07	39.69	21
County road	0.162	0.135	32.69	12.67	14
Federal road	0.089	0.051	53.00	22.63	2
State road	0.071	0.039	68.53	90.08	3
Township road	0.100	0.041	78.05	81.25	2
Pipelines	0.409	0.127	32.25	18.74	2
Railroads	0.122	0.077	20.06 [a]	5.96	6

[a] Based on $N = 5$

Forage along road right of ways did not differ by road type ($F_{3,17} = 0.63$, $P = 0.61$) but differed by right of way type (all road types combined, pipelines, and railroads; $F_{2,26} = 4.53$, $P = 0.02$; Figure 5) as pipeline right of ways had more forage than road (Tukey test $P = 0.02$) and railroad (Tukey test $P = 0.03$) right of ways.

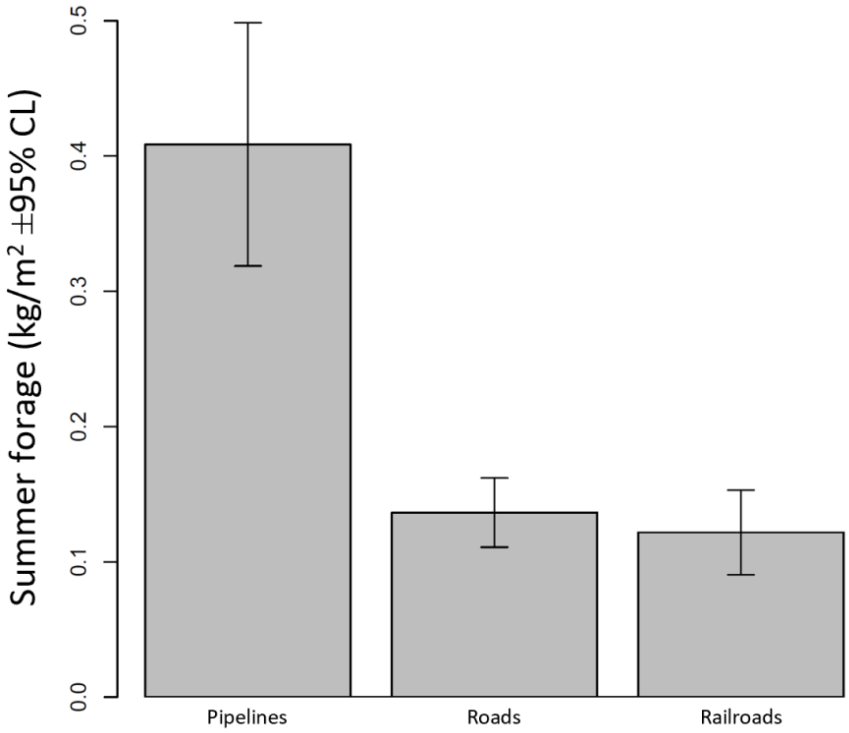

Figure 5. Summer forage along 3 right of way types in northeastern Minnesota.

Animal unit equivalence

Winter AUE ranged from 1 to 9 elk/16 km^2 across all study areas (Figure 6A). Mean winter AUE was 5 elk/16 km^2 (*SD* = 1 elk/16 km^2, *N* = 7,841,931 raster cells) on the Cloquet Valley study area, and was 1.2 times greater on the Fond du Lac study area (6 elk/16 km^2, *SD* = 1 elk/16 km^2, *N* = 3,402,931 raster cells) and 1.6-times greater on the Nemadji study area (8 elk/16 km^2, *SD* = 1 elk/16 km^2, *N* = 4,279,849 raster cells).

Summer AUE was greater than winter AUE, ranging from 14 to 83 elk/16 km^2 across the study areas (Figure 6B). Mean summer AUE was 58 elk/16 km^2 (*SD* = 8 elk/16 km^2, *N* = 7,841,931 raster cells) on the Cloquet Valley study area, and 1.2 time greater on the Fond du Lac study area (67 elk/16 km^2, *SD* = 6 elk/16 km^2, *N* = 3,402,931 raster cells) and the Nemadji study area (69 elk/16 km^2, *SD* = 4 elk/16 km^2, *N* = 4,279,849 raster cells).

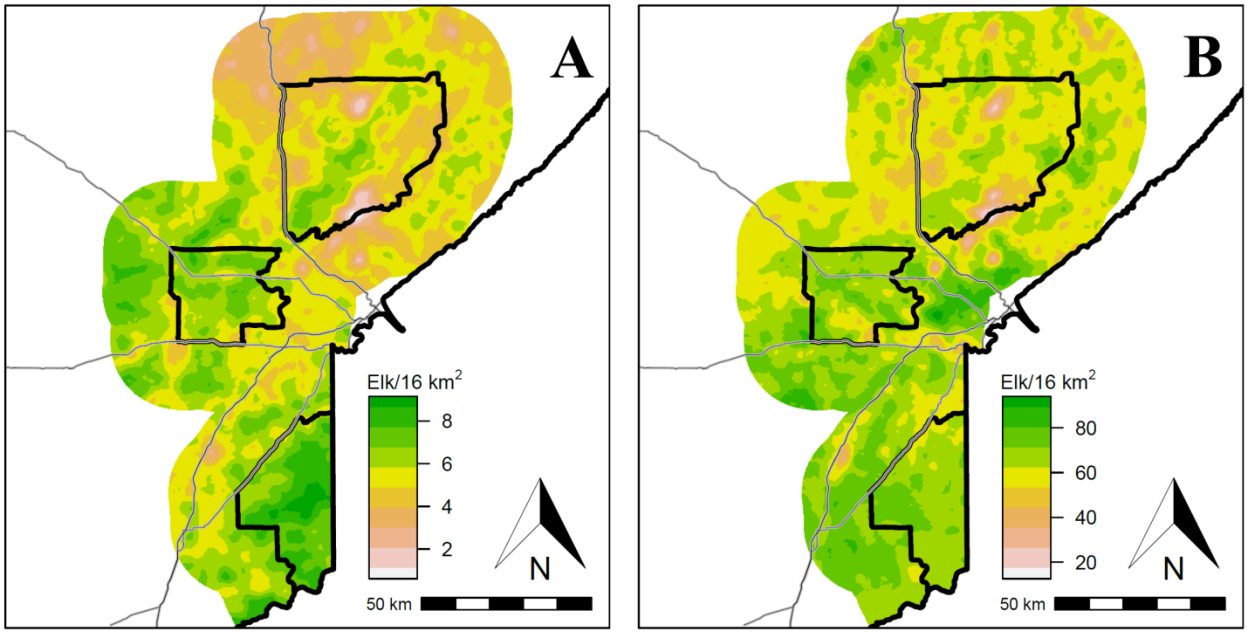

Figure 6. Winter (A) and summer (B) animal unit equivalence estimates for elk in northeastern Minnesota.

Biological carrying capacity

Winter carrying capacity (K_w) estimates based on mean AUE ranged from 287 on the Fond du Lac study area to 551 elk on the Cloquet Valley study area (Table 6). Estimates based on the *SD* of AUE ranged from 193 elk on the Fond du Lac to 768 elk on the Cloquet Valley study area.

Table 6. Winter biological carrying capacity estimates for 3 study areas in northeastern Minnesota. Estimates are for the 3 study areas but not the surrounding areas.

Study area	Area (km^2)	K_w (range) [a]
Cloquet Valley	1,764	551 (335 to 768)
Fond du Lac	766	287 (193 to 381)
Nemadji	963	481 (364 to 599)

[a] Carrying capacity estimate for winter; range is from 1.96 × *SD* of AUE.

Habitat suitability

Suitability maps of winter forage (Figure 7A), spring forage (Figure 7B), and winter cover (Figure 7C) resulted in a map of overall suitability (Figure 6D) after accounting for road density and ownership. Overall suitability within the 3 study areas ranged from 0 to 0.68. Mean overall suitability was similar across study areas (Figure 7D). Mean overall suitability was 0.45 (*SD* = 0.17, *N* = 7,831,119 raster cells) on the Cloquet Valley study area, 0.45 (*SD* = 0.16, *N* = 3,402,931 raster cells) on the Fond du Lac study area, and 0.43 (*SD* = 0.17, *N* = 4,279,849 raster cells) on the Nemadji study area.

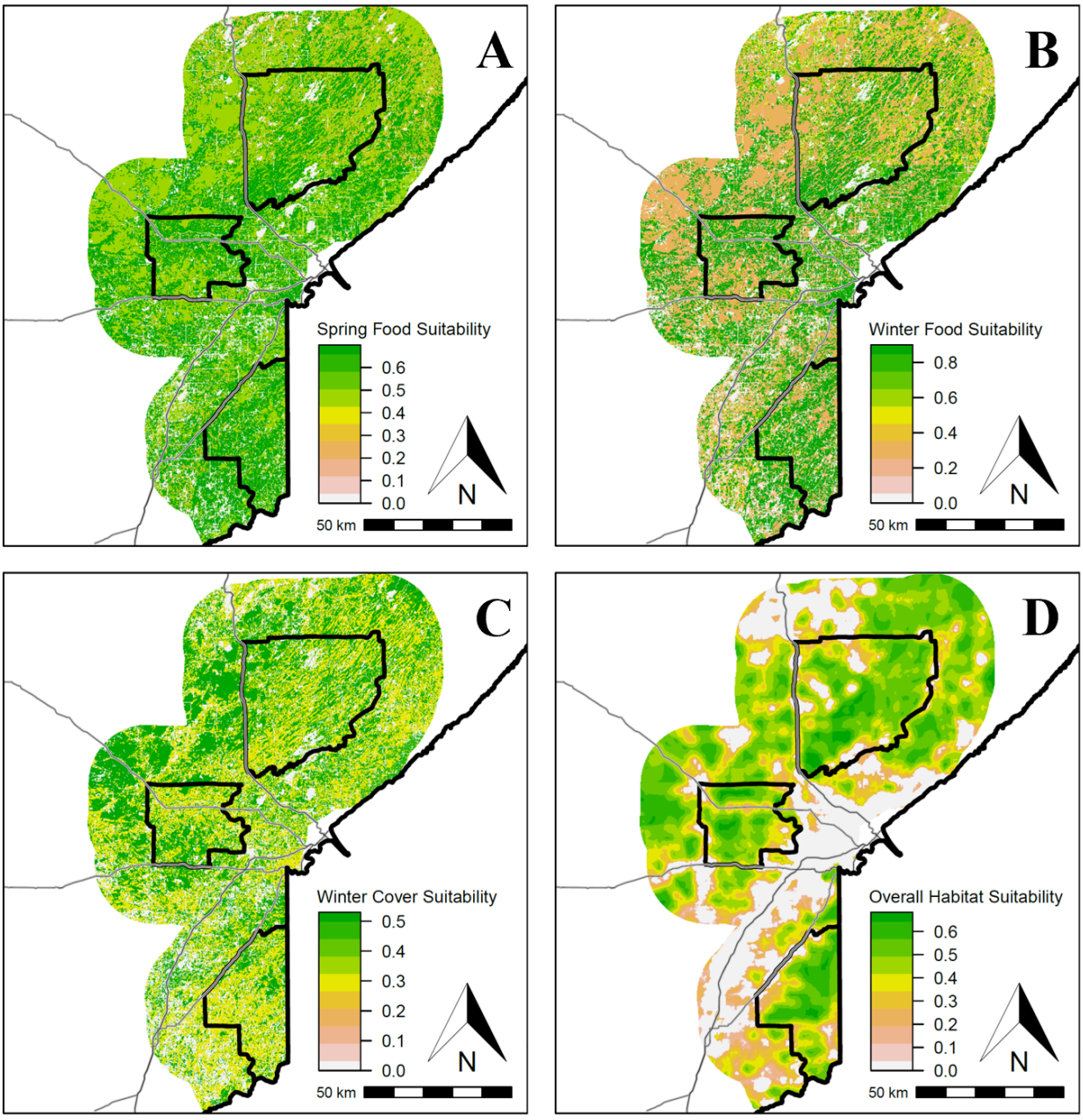

Figure 7. Spring food (A), winter food (B), winter cover (C), and overall suitability indices (D) for elk in northeastern Minnesota.

Resource selection

Summer resource selection function scores reflected increasing relative probability of selection (1 = low probability and 4 = high probability). When we included known wolf territories in relative selection calculations, the Nemadji study area had mean selection scores 2.6- and 3-times higher than the Cloquet Valley and Fond du Lac study areas (Figure 8A). The Cloquet Valley study area had a mean relative summer selection score of 1.55 (*SD* = 0.68, *N* = 7,841,931 raster cells), while the Fond du Lac study area had a mean of 1.34 (*SD* = 0.57, *N* = 3,402,931 cells), and the Nemadji study area had a mean of 3.99 (*SD* = 0.08, *N* = 4,279,849 cells). Selection was high on the Nemadji study area because wolf pack territory location influences selection scores (Anderson et al. 2005*b*), but we were missing wolf territory data from packs there.

When we excluded the influence of wolf territories in selection calculations, mean selection score differences were smaller (Figure 8B). The Nemadji study area had mean selection scores 1.5- and 1.3-times higher than the Cloquet Valley and Fond du Lac study areas. The Cloquet Valley study area had a mean relative summer selection score of 2.19 (*SD* = 1.02, *N* = 7,841,931 raster cells), while the Fond du Lac study area had a mean of 2.49 (*SD* = 0.97, *N* = 3,402,931 cells), and the Nemadji study area had a mean of 3.23 (*SD* = 0.88, *N* = 4,279,849 cells).

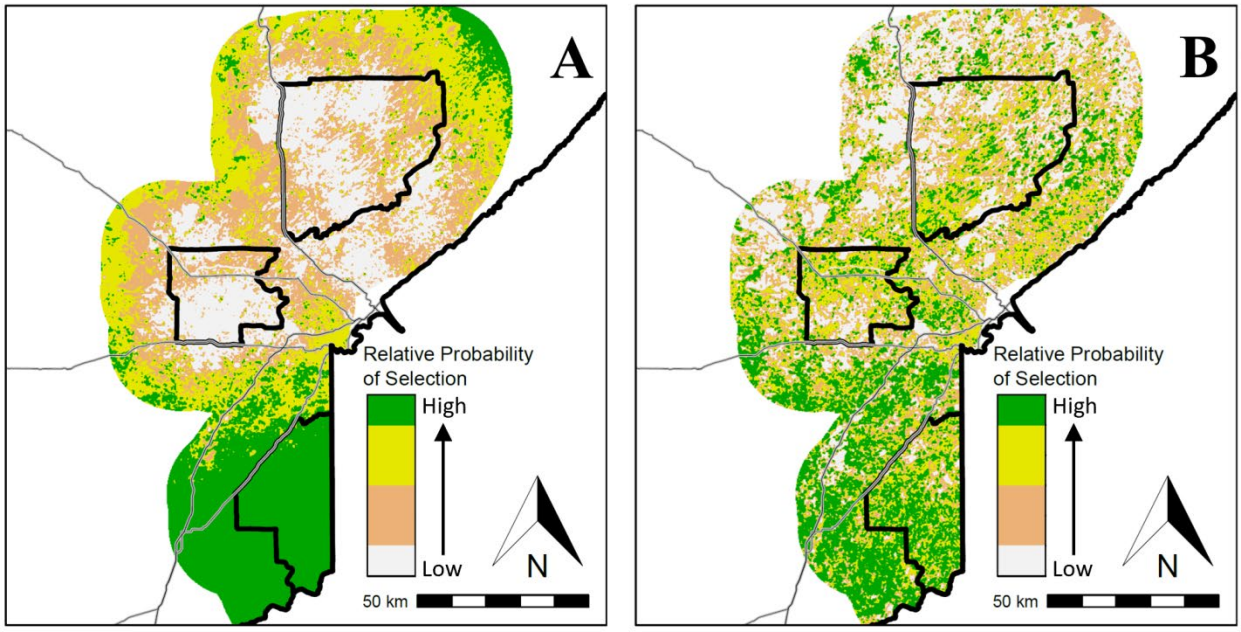

Figure 8. Relative probability of resource selection by elk in northeastern Minnesota with (A) and without (B) influence of monitored wolf packs. Wolf data were unavailable for the Nemadji study area.

Aspen, grassland, and public land

Aspen was most common on the Cloquet Valley study area. It was 4.3 times greater on the Cloquet Valley study area (mean proportion = 0.17 aspen, *SD* = 0.09 aspen, *N* = 7,841,931 raster cells) than on the Fond du Lac study area (0.04 aspen, *SD* = 0.03 aspen, *N* = 3,402,931 cells), and 5.7 times greater than on the Nemadji study area (0.03 aspen, *SD* = 0.04 aspen, *N* = 4,279,849 cells; Figure 9A).

Grassland distribution was similar across the 3 study areas. The Cloquet Valley study area was a mean of 0.054 grassland (*SD* = 0.04 grassland, *N* = 7,841,931 raster cells), while the Fond du Lac study area was 0.040 grassland (*SD* = 0.03 grassland, *N* = 3,402,931 cells), and the Nemadji study area was 0.048 grassland (*SD* = 0.03 grassland, *N* = 4,279,849 cells; Figure 9B).

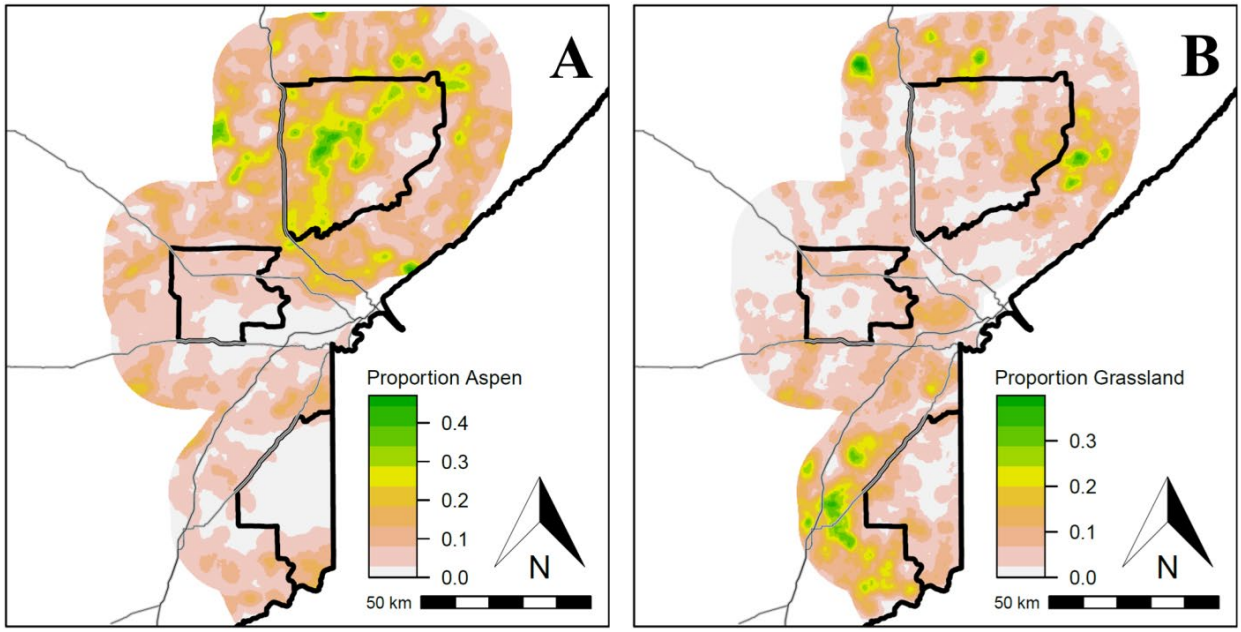

Figure 9. Proportion of area that was aspen (A) and grassland (not hay/pasture; B) in northeastern Minnesota.

Public land was in greatest abundance on the Cloquet Valley study area, and similar on the Fond du Lac and Nemadji study areas. The Cloquet Valley study area was a mean of 0.75 public land (*SD* = 0.26 public land, *N* = 7,841,931 raster cells), while the Fond du Lac study area was 0.61 public (*SD* = 0.27 public, *N* = 3,402,931 cells), and the Nemadji study area was 0.60 (*SD* = 0.34 public, *N* = 4,279,849 cells; Figure 10).

Social acceptance

Landowners

Most landowners supported elk restoration. Overall, 776 (82%) of 950 questionnaire respondents who owned ≥ 4 ha of land inside the 3 study area boundaries expressed favorable attitudes toward elk restoration (attitude scores ≥ 5; Table 7). Logistic regression analysis of unfavorable (scores ≤ 3) and favorable attitudes (scores ≥ 5) showed landowner support for elk restoration did not differ between study areas (Wald $|z| \leq 1.35$ and $P \geq 0.17$ for all pairwise comparisons).

Mapping acceptance scores from landowners who owned ≥ 4 ha of land inside and outside (≤ 8 km away) from the study areas (*N* = 2,585 questionnaire responses) using a moving window showed high mean acceptance across the 3 study areas (Figure 11A). Mean acceptance was 5.7 (*SD* = 0.20, *N* = 7,841,931 raster cells) on the Cloquet Valley study area, 5.5 (*SD* = 0.15, *N* = 3,402,931 cells) on the Fond du Lac study area, and 5.8 (*SD* = 0.14 *N* = 4,279,849 cells) on the Nemadji study area.

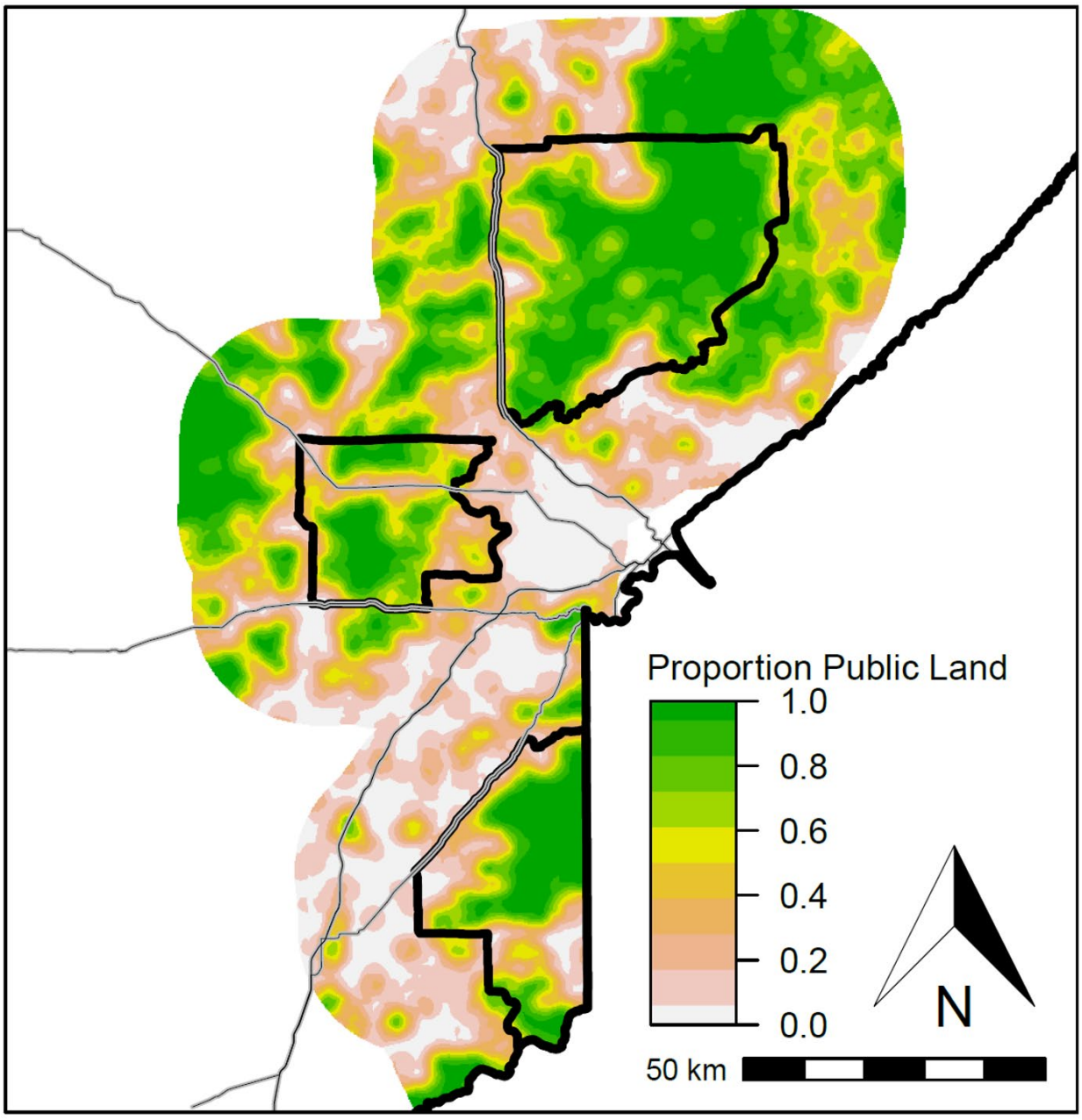

Figure 10. Proportion of land under public ownership in northeastern Minnesota.

Local residents

Most local resident survey respondents supported elk restoration. Overall, 105 (86%) of 122 local resident questionnaire respondents with addresses inside the 3 study area boundaries expressed favorable attitudes toward elk restoration (attitude scores ≥ 5; Table 6). Logistic regression analysis of unfavorable and favorable attitudes local resident attitudes did not differ between study areas (Wald $|z| \leq 2.23$ and $P \geq 0.49$ for all pairwise comparisons).

Table 7. Acceptance scores for landowners (owned ≥ 4 ha of land) and local residents (owned < 4 ha of land) in 3 northeastern Minnesota study areas. Scores presented here are for questionnaire respondents from inside the study area boundaries. See the results from our moving window mapping and the companion report by Walberg et al. (2019) for additional analyses that included landowners and local residents from inside and outside the study area boundaries.

	Landowners: count (proportion) of acceptance scores [a]							
Study area	1	2	3	4	5	6	7	Sum
Cloquet Valley	24 (0.07)	9 (0.03)	8 (0.02)	23 (0.07)	37 (0.11)	90 (0.27)	142 (0.43)	333
Fond du Lac	16 (0.08)	4 (0.02)	4 (0.02)	22 (0.11)	17 (0.08)	69 (0.33)	77 (0.37)	209
Nemadji	20 (0.05)	11 (0.03)	7 (0.02)	26 (0.06)	45 (0.11)	103 (0.25)	196 (0.48)	408
Sum (landowners)	60 (0.06)	24 (0.03)	19 (0.02)	71 (0.07)	99 (0.10)	262 (0.28)	415 (0.44)	950

	Local residents: count (proportion) of acceptance scores							
Study area	1	2	3	4	5	6	7	Sum
Cloquet Valley	6 (0.08)	1 (0.01)	0 (0.00)	6 (0.08)	13 (0.17)	18 (0.23)	34 (0.44)	78
Fond du Lac	0 (0.00)	1 (0.05)	0 (0.00)	1 (0.05)	4 (0.18)	8 (0.36)	8 (0.36)	22
Nemadji	1 (0.05)	0 (0.00)	0 (0.00)	1 (0.05)	2 (0.09)	8 (0.36)	10 (0.45)	22
Sum (local residents)	7 (0.06)	2 (0.02)	0 (0.00)	8 (0.07)	19 (0.10)	34 (0.28)	52 (0.43)	122

[a] 1 = low acceptance, 4 = neutral, 7 = high acceptance.

Moving window analysis of questionnaire responses from local residents with addresses inside and outside the 3 study areas (N = 1,521 responses) showed acceptance scores were high across the study areas (Figure 11B). Mean acceptance was 5.6 (SD = 0.40, N = 7,841,931 raster cells) on the Cloquet Valley study area, 5.4 (SD = 0.30, N = 3,402,931 cells) on the Fond du Lac study area, and 5.7 (SD = 0.38, N = 4,279,849 cells) on the Nemadji study area.

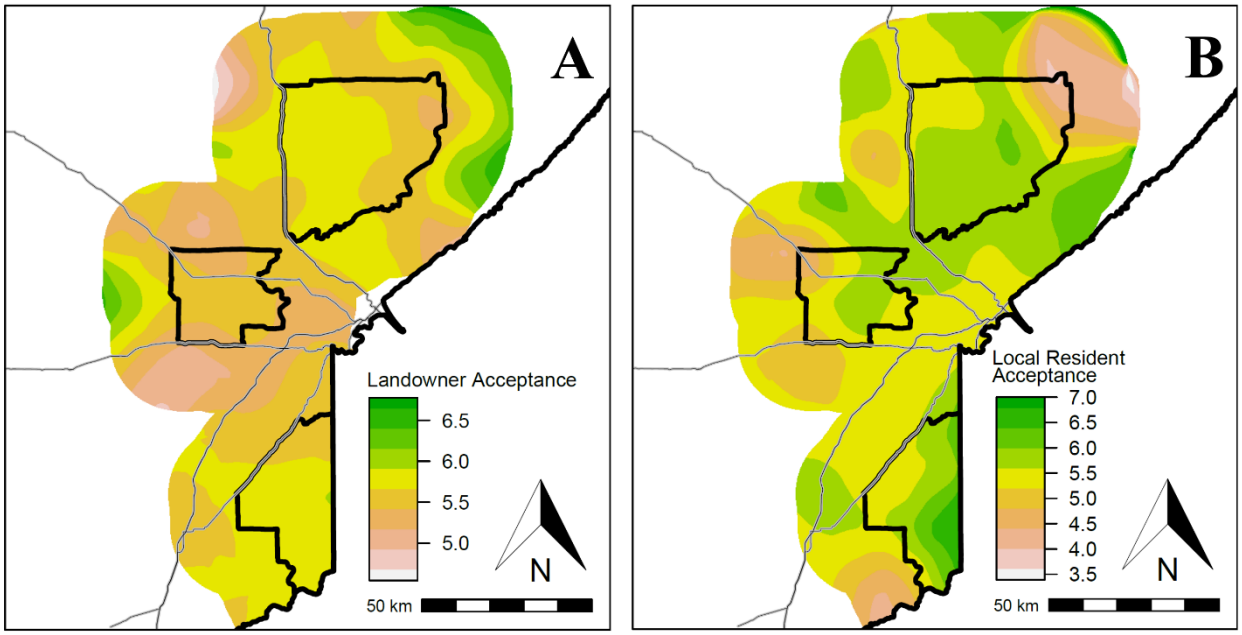

Figure 11. Social acceptance of elk restoration by landowners (A) and local residents (B) on and near 3 study areas in northeastern Minnesota. Acceptance ranges from 1 (low) to 7 (high). The scale bars start at values > 0 as minimum mean acceptance was 4.5 for landowners and 3.4 for local residents.

Risk of human-elk conflict

Conflict risk averaged ≤ 0.10 across the 3 study areas, increasing from north to south (Figure 12). Mean risk on the Cloquet Valley study area was 0.02 (SD = 0.02, N = 7,841,931 raster cells), while risk on the Fond du Lac study area was 2-times greater (mean = 0.04, SD = 0.03, N = 3,402,931 cells) and risk on the Nemadji study area was 5-times greater (mean = 0.10, SD = 0.05, N = 4,279,849 cells). Areas southwest of the Nemadji study area, between the Nemadji and Fond du Lac study areas, and south of the Fond du Lac study area had greater risk (Figure 12).

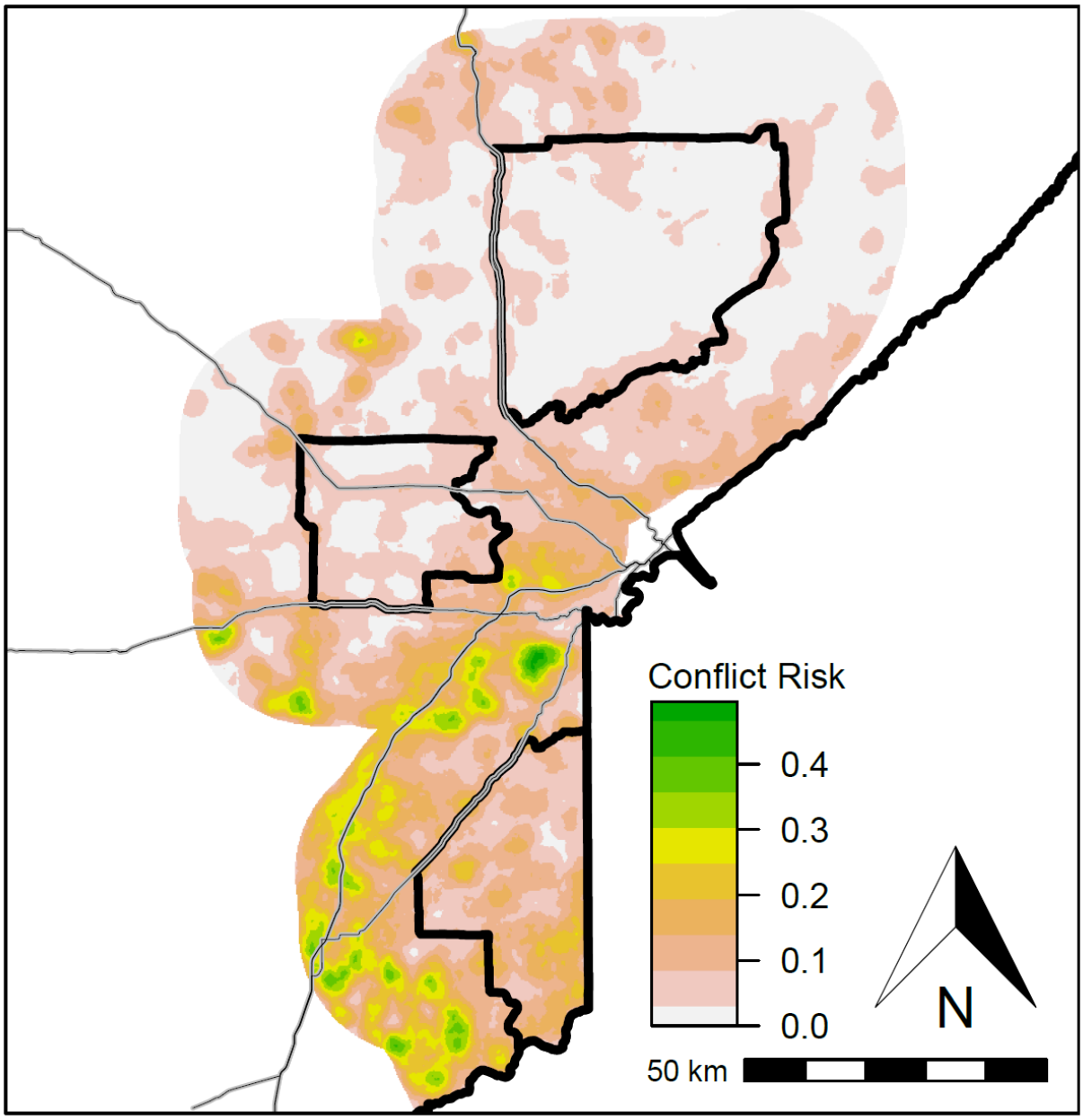

Figure 12. Risk of human-elk conflict in northeastern Minnesota. Conflict risk is the proportion of area that is roads, feedlots, hay/pasture, and row crops.

Winter suitability

By intersecting landowner acceptance scores ≥ 5 with the greater than average winter animal use equivalence and winter habitat suitability, we estimated that 443 km^2 of the Cloquet Valley study area (0.25 of the study area) had both high landowner acceptance and high winter habitat suitability (Figure 13). We estimated that the Fond du Lac study area had 234 km^2 (0.30 of the study area; 1.2 times more than the Cloquet Valley study area) and the Nemadji study area had 138 km^2 (0.14 of the study area) of high winter habitat suitability and landowner acceptance (0.6 and 0.5 times than on the Cloquet Valley and Fond du Lac study areas).

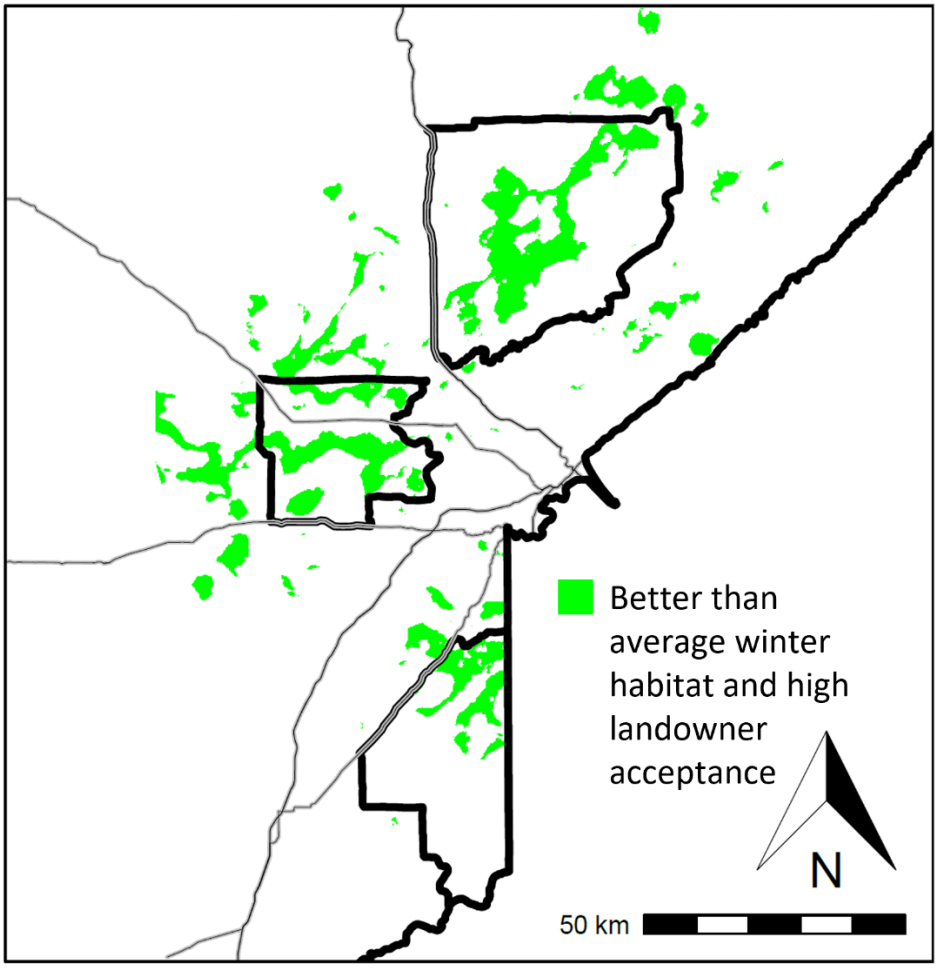

Figure 13. Areas where winter animal use equivalence and winter habitat availability were better than the mean, and landowner support was high (acceptance score ≥ 5).

Ranking study areas

Study areas ranks were similar when we weighted each factor equally. The Cloquet Valley study area had the highest mean rank (1 = worse and 3 = better; Table 8), but ranks were not significantly different (Permutation test; max $T = 1.56$, $P = 0.26$).

Weighting factors resulted in differences between study areas. It required weighting factors a mean of 5.9 times (range 4 to 10 times, $SD = 2.4$ times, $N = 9$ sets of comparisons) to obtain ≥ 1 statistically significant pairwise difference. All 9 sets of 10 weighted comparisons had at least 1 statistically significant pairwise difference (Figure 14). Pairwise post hoc tests that followed significant one-way permutation tests resulted in a mean rank for the Cloquet Valley study area that was greater than the rank for at least 1 other study area in 7 of the 9 sets of comparisons, and less than at least 1 other study area in 2 sets of comparisons (Figure 14). The Nemadji study area had a greater mean rank than at least 1 other study area in 4 of the 9 sets of comparisons, and less than at least 1 other study area in 5 of the 9 sets of comparisons. The Fond du Lac study area had a greater mean rank than at least 1 other study area in 3 of the 9 sets of comparisons, and a lower rank than at least 1 other study area in all of them.

Table 8. Study area ranks (1 = worst and 3 = best) for factors that influence elk restoration success.

Study area	Winter animal use equivalence	Wisconsin habitat suitability index [a]	Summer resource selection [b]	Proportion aspen	Proportion grassland	Proportion public land	Landowner acceptance	Conflict risk	Mean with equal weights
Cloquet Valley	1	3	1	3	3	3	2	3	2.4
Fond du Lac	2	2	2	2	1	2	1	2	1.8
Nemadji	3	1	3	1	2	1	3	1	1.9

[a] Overall suitability score.

[b] Excluded wolf data, as recent wolf territory data for Nemadji study area were not available.

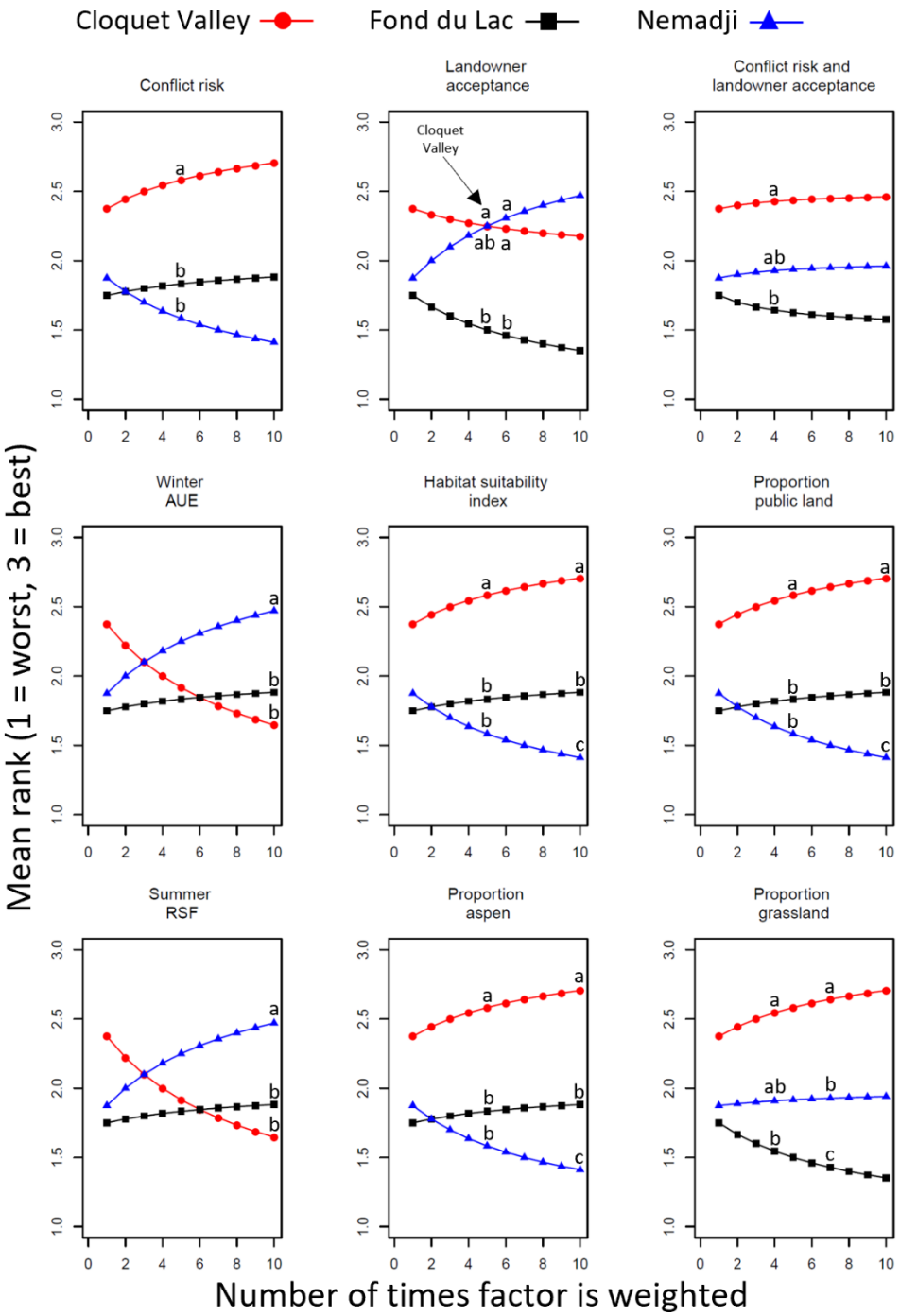

Figure 14. Mean rank of 3 northeastern Minnesota study areas after weighting factors between 1 (even weights) to 10 (factor counted 10 times). Plot titles indicate weighted factor(s). Letters a, b, and c within plots are first instances of statistically significant pairwise differences that continue to be significant at greater weights. For example, the Cloquet Valley rank was first statistically greatest at conflict risk weight = 5 and continued to be greater at ranks ≥ 5. There were 2 sets of differences for panels that have > 1 set of letters. AUE = animal use equivalence. RSF = resource selection function.

Thresholds from other elk studies

Each study area had ≥ 390 km^2 with preferred summer forage and ≥ 225 km^2 of winter forage that was ≥ forage available to elk in Wisconsin (Table 9; Figure 15A and 15B). Each study area had > 740 km^2 with winter AUE ≥ elk density in Wisconsin's Black River Herd (after converting Wisconsin density to elk/km^2; Figure 15C). Areas with winter AUE ≥ elk density in Michigan ranged widely, from a low of 31 km^2 in the Cloquet Valley study area to a high of 720 km^2 in the Nemadji study area. The Wisconsin habitat suitability index was ≥ 0.5 in > 270 km^2 of each study area, equaling 0.35 to 0.45 of each study area (Figure 15D).

Table 9. Amount of each study area ≥ threshold values from elk studies.

	Area (km^2) and proportion of study area above threshold				
Study area / Threshold	Summer forage ≥ 0.120 kg/m^2	Winter forage ≥ 0.017 kg/m^2	Winter AUE [a] ≥ 5 elk/16 km^2	Winter AUE ≥ 7 elk/16 km^2	Wisconsin Habitat Suitability Index ≥ 0.5
Cloquet Valley	642 (0.36)	225 (0.13)	908 (0.51)	31 (0.02)	800 (0.45)
Fond du Lac	390 (0.51)	240 (0.31)	743 (0.97)	152 (0.20)	271 (0.35)
Nemadji	586 (0.61)	449 (0.47)	963 (1.00)	720 (0.75)	403 (0.42)

[a] AUE = Animal use equivalence.

Discussion

Suitable environmental conditions and social acceptance are important for restoring wildlife populations (Fischer and Lindenmayer 2000, Behr et al. 2017). Our results show abundant suitable elk habitat in northeastern Minnesota, and high landowner and local resident support for restoring elk there. Our social suitability results correspond well with a companion report by Walberg et al. (2019) who examined the same landowner and local resident support data in additional ways using different statistical methods.

Forage availability at field plots suggests northeastern Minnesota can support elk. Summer forage on our study areas (0.130 kg/m^2) exceeded amounts elk prefer (0.120 kg/m^2; Wilmshurst et al. 1995). Winter forage on our study areas (0.017 kg/m^2) was the same as in Wisconsin when we excluded grass from Wisconsin estimates (0.017 kg/m^2; Anderson et al. 2005*a*), which made sense as elk rarely consume grass during winter in eastern North America (Jenkins et al. 2007).

AUE estimates indicate northeastern Minnesota can support densities of elk found in Wisconsin and Michigan. Winter AUE in our study (5 to 8 elk/16 km^2) corresponds well with elk densities in Wisconsin's Black River Herd (5 elk/16 km^2) and in Michigan (7 elk/16 km^2; Stowell et al. 2012, MIDNR 2019, WDNR 2019*a*). They were 1.7- to 2.7-times higher than densities in Wisconsin's Clam Lake Herd (3 elk/16 km^2; Stowell et al. 2012, WDNR 2019*b*).

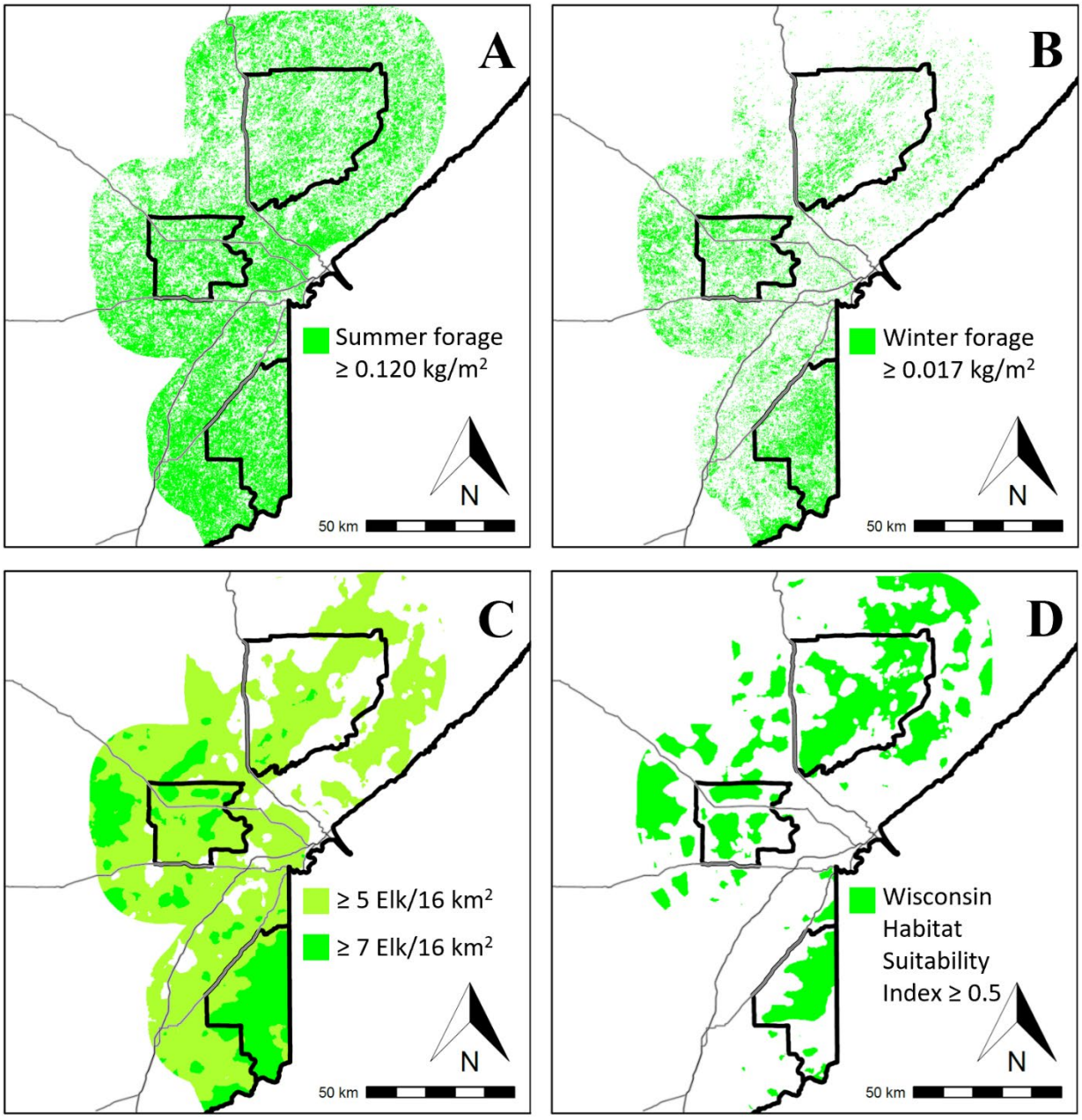

Figure 15. Areas with summer forage (A), winter forage (B), winter animal use equivalence (C), and habitat suitability (D) that are ≥ threshold values from elk studies.

Our study areas had large amounts of habitat with suitability scores similar to where elk occur in Wisconsin (habitat suitability index scores ≥ 0.5; Gilbert et al. 2010, Stowell et al. 2012). Using Wisconsin's Black River Herd's approximately 200 km^2 core area as a reference (Stowell et al. 2012, WDNR 2019*a*), the Cloquet Valley contained about 4-times more suitable habitat, the Nemadji study area contained about 2-times more suitable habitat, and the Fond du Lac study area contained about the same amount of suitable habitat.

Conflict risk adjacent to our study areas may influence public support for elk population expansion. It is likely that low conflict risk in all directions adjacent to the Cloquet Valley study area will enable elk population expansion without eroding public support. Low risk to the west, north, and east from the Fond du Lac study area will also enable elk population expansion. In contrast, areas in Minnesota in all directions from the Nemadji study area had high risk, making it likely that human-elk conflict will reduce public support for elk population expansion there.

Ranking the 3 study areas for elk restoration will be influenced by whether the factors considered are perceived as being equally important or if some factors are perceived as more important than others. Ranking study areas while considering each factor to be equally important (evenly weighted factors) suggests that the 3 study areas were equally suitable for elk restoration (study areas were not statistically different). The study areas were not equally suitable for elk restoration (statistically different study area ranks), however, when we considered some factors to be more important (unevenly weighted factors). Thus, the perceived relative importance of factors we assessed, and others, will influence study area selection if restoration moves forward.

The Cloquet Valley study area is more likely to be considered best for elk restoration when 1 or more of the factors we assessed is perceived to be ≥ 4 times more important than others. Compared to the other study areas, the Cloquet Valley study area had the highest rank most often (statistically greatest rank) when we weighted factors. It ranked best when we weighted each of 5 factors 4 to 7 times (conflict risk, Wisconsin's habitat suitability index, and proportions of public land, aspen, and grassland). By comparison, the Nemadji study area only had the best rank when we weighted each of 2 factors 10 times (winter AUE and summer RSF), and the Fond du Lac study area never rank best.

Multiple methods yielded high habitat suitability estimates, which strengthens our conclusions (Johnson 2007). It is important to note, however, that maps we developed have limitations. For example, although we developed summer AUE maps using forage models that were often within 0.05 kg/m^2 of field observations, these models were only 30% accurate, reflecting difficulty in estimating small diameter shrub and tree biomass over broad areas well.

Predation is likely to influence elk restoration success. Black bears (*Ursus americanus*) and wolves (*Canis lupus*) are present in northeastern Minnesota and both kill elk, thereby reducing restoration success (Frair et al. 2007, Popp et al. 2014, Keller et al. 2015). Resource selection functions we developed showed that wolves will influence elk distributions but did not estimate the influence of predation on population growth. Prior restoration efforts show bears and wolves kill restored elk (WDNR 2019*a*), but surviving elk reduce mortality rates by learning to avoid predators (Frair et al. 2007).

Disease transmission is an important factor when considering elk restoration, but we did not address it in this assessment. Brainworm (*Parelaphostrongylus tenuis*) and chronic wasting disease (CWD) infections, for example, are present in wild ungulates in Minnesota (MNDNR 2017, Carstensen et al. 2018) and kill elk (Keller et al. 2015). Brainworm spreads via consumption of intermediate hosts (snails and slugs), while CWD spreads via direct contact between animals and through exposure to materials contaminated by urine, saliva, feces, and

carcasses of infected animals (Gillin et al. 2018). Brainworm is associated with white-tailed deer (*Odocoileus virginianus*) distributions in eastern North America, including in northeastern Minnesota. CWD, however, has not been detected in northeastern Minnesota and CWD transmission risk makes wildlife managers hesitant to relocate cervids (Gillin et al. 2018).

We did not address climate change in this assessment, as we expect elk to adapt to northeastern Minnesota's warming climate. Northeastern Minnesota is projected to have a climate similar to Iowa by 2069 (Galatowitsch et al. 2009), but the range, physiology, and foraging behavior of elk suggest they are not adversely affected by warm climates. The historic elk range included warm areas in North America and elk currently occur in warm climates of Arkansas, Iowa, Kentucky, North Carolina, and Texas (Kagima and Fairbanks 2013; Popp et al. 2014). Although climate warming has been implicated in moose population declines (Weiskopf et al. 2019), elk have a higher upper critical temperature than moose (about 10 °C higher during summer; Parker and Robbins 2009; McCann et al. 2013), suggesting elk will adapt to a warmer climate in northeastern Minnesota. Being mixed feeders that locate forage in many habitat types, elk will also likely adapt to projected habitat conversion to savanna and grassland.

Our findings show widespread suitable habitat and public support for elk restoration in northeastern Minnesota. Human-elk conflict risk is low on our study areas but is high in some nearby areas where a restored elk population might expand. Factors we assessed in this report, and factors we did not assess, require consideration when deciding whether to restore elk.

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NORTHEASTERN MINNESOTA ELK

A study of landowner and public attitudes toward potential elk restoration in Minnesota

Final Summary

A cooperative study conducted by:

Minnesota Cooperative Fish and Wildlife Research Unit

Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota

Fond du Lac Band of Lake Superior Chippewa

NORTHEASTERN MINNESOTA ELK

A study of landowner and public attitudes toward potential elk restoration in Minnesota

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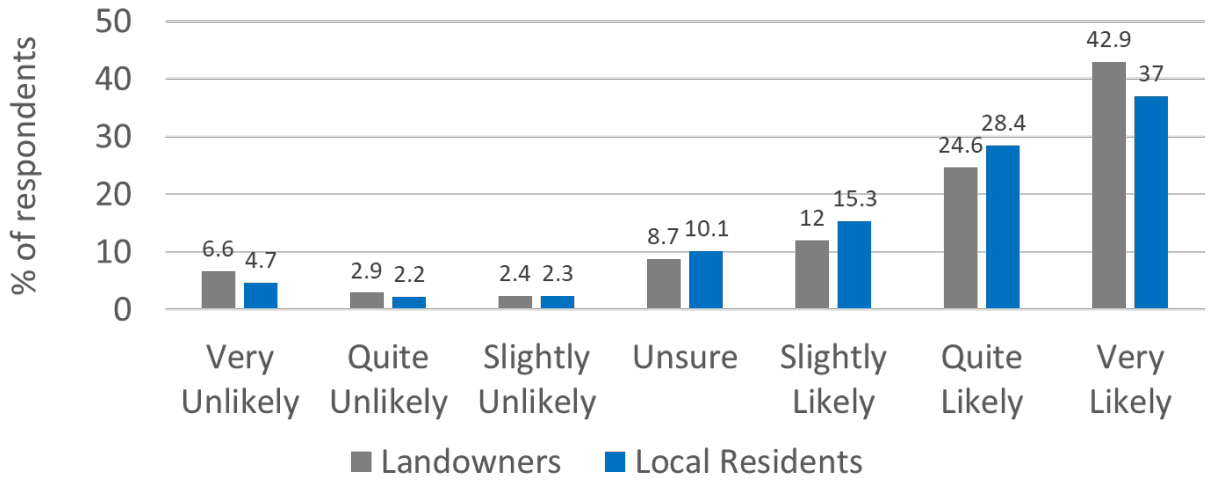
Executive Summary

Understanding the public's attitudes and acceptance of elk and their potential impacts are key components of assessing the viability of elk restoration. The University of Minnesota, in collaboration with the Fond du Lac Band of Lake Superior Chippewa, conducted a self-administered mail-back questionnaire of landowners and local residents in northeastern Minnesota to determine their attitudes toward restoring an elk population. We surveyed 4,500 private landowners and 4,000 local residents in northeastern Minnesota to describe landowner and local resident attitudes toward potentially restoring an elk population to northeastern Minnesota. The population of interest in this study was private landowners and local residents within the study area that covered portions of Carlton, Pine, and St. Louis Counties. Three potential restoration areas for elk were identified based on recommendations from local natural resource professionals. These areas were selected due to abundant public land, while minimizing potential conflict from other land uses (e.g., agriculture). A random sample was used for: (1) private landowners ($\geq$10 acres) within five miles of the restoration areas, and (2) local residents matched to census blocks within four areas that correspond to county boundaries and major landmarks (e.g., roads, river). Among landowners, we had an adjusted response rate of 60% for full-length surveys, and a total response rate of 67% including nonresponse surveys. Among local residents, we had an adjusted response rate of 46% for full-length surveys, and a total response rate of 49% including nonresponse surveys.

Support for Elk Restoration

Overall landowners and local residents within the study areas strongly supported restoring wild, free-ranging elk to the study areas in northeastern Minnesota (80% and 81%; Figure S-1) and Minnesota in general (78% and 78%). About 12% of landowners and 9% of local residents were unlikely to support elk restoration. Landowner support for restoration in northeastern Minnesota was highest in the Cloquet Valley Study Area (82%) and lowest in the Fond du Lac Study Area (75%). Support from landowners in the Nemadji Study Area was 81%. Among local residents support was highest in southern St. Louis County (83%) followed by Duluth (82%), northern Pine County (78%) and Carlton County (75%). Overall, a majority of landowners were supportive of restoring elk on their own property (70%) and within five miles of their property (76%). Landowners and local residents within each study area and group strongly supported restoring elk, although landowners were slightly less supportive of restoring elk within close proximity to their own property.

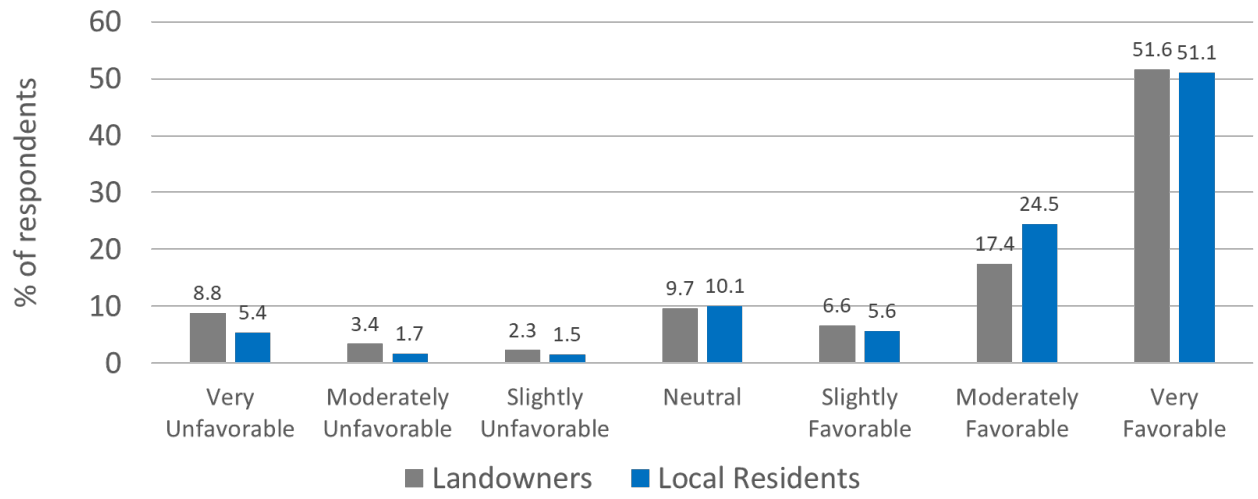
Figure S-1. Support for restoring wild, free-ranging elk to the study areas in Minnesota.



Hunters were more supportive of restoring elk to the study areas in Minnesota than non-hunters among both landowners (81% vs 75%) and local residents (80% vs 75%). Among landowners, non-farmers were more supportive of restoring elk to the study areas in Minnesota than farmers (82% vs 73%). Timber producing landowners were less supportive of restoring wild, free-ranging elk to the study areas in Minnesota than non-producers (76% vs 81%).

Overall, both landowners (76%) and local residents (81%) also expressed favorable feelings toward elk restoration in the identified study areas and on average held positive attitudes toward supporting the restoration of elk in these areas (Figure S-2). About 12% of landowners felt moderately to very unfavorably toward restoring elk in the study areas, while only 7% of local residents felt moderately to very unfavorably toward restoring elk. Over 70% of landowners and local residents also held normative beliefs that people who are important to them think they should support the restoration of elk in the study areas. Overall, attitudes toward supporting restoration of elk and normative beliefs about supporting the restoration of elk, explained a large amount of the variance in landowners' (63%) and local residents' (52%) level of support for restoring elk.

Figure S-2. Feelings expressed toward restoring wild, free ranging elk to the study areas in Minnesota.



Landowners and local residents were presented with a series of 14 potential outcomes from restoring a wild, free-ranging elk population within the study areas in Minnesota and asked the likelihood of each outcome. Respondents believed that the most likely outcomes from restoring an elk population were: (1) providing opportunities to view elk, (2) restoration of a native wildlife species, and (3) providing opportunities to hunt elk. Respondents believed that the least likely outcomes from restoring an elk population were: (1) negatively impact other wildlife populations, (2) increase risk of disease transmission to livestock and wildlife, and (3) increase damage to trees and forest vegetation. The beliefs that had the largest positive influence on landowner and local resident support for elk restoration included: (1) restoration of a native wildlife species; (2) providing economic opportunities; (3) increase youth involvement and interest in the outdoors; (4) providing hunting opportunities for elk; and (5) providing opportunities to view elk. Beliefs that had the largest negative influence on support included: (1) negatively impact other wildlife populations, (2) increase risk of disease transmission to livestock and wildlife, and (3) increase damage to trees and forest vegetation.

Importance of Issues Related to Elk Restoration

Understanding landowners' and local residents' preferences for management objectives allows managers to understand stakeholder desires for potentially restoring elk to study areas in Minnesota and improve implementation of tools, such as education. We used a Best-Worst Scaling (BWS) approach to determine preferences regarding the most important and least important objectives to stakeholders. Landowners and local residents ranked management objectives similarly. The most important management objectives for landowners were: (1) minimizing impacts to existing wildlife populations (e.g., disease, resource competition), (2) restoration of a native species, and (3) minimizing impacts to deer populations and deer hunting. The least important management objectives for landowners were: (8) minimizing costs of government elk management actions, (9) providing elk viewing opportunities, and (10) maximizing economic opportunities through elk-related tourism and recreation. The most important management objectives for local residents were: (1) minimizing impacts to existing wildlife populations (e.g., disease, resource competition), (2) restoration of a native species, and (3) maximizing sustainable elk population

size. The least important management objectives for local residents were: (8) providing elk hunting opportunities, (9) maximizing economic opportunities through elk-related tourism and recreation, and (10) providing elk viewing opportunities.

Benefits and Risks of Restoring Elk

We were interested in understanding landowners' and local residents' perceptions of the potential risks and benefits from restoring wild, free-ranging elk within the study areas in Minnesota. Landowners and local residents perceived that there would potentially be moderate risk from restoring elk within the study areas. Landowners and local residents thought that having elk within the study areas would pose little to moderate threat to the respondents' own economic well-being (agriculture, personal property) or health/safety (vehicle collisions, etc.). Similarly, landowners and local residents believed that having elk within the study areas would pose little to moderate threat to the economic well-being (agriculture, personal property) or health/safety (vehicle collisions, etc.) of other individuals in the local community. Landowners and local residents perceived that having elk within the study areas would pose moderate threat to other wildlife in the area (disease, etc.) and to trees and forest vegetation. Overall, landowners and local residents perceived that elk would pose the greatest threat to the health/safety of other individuals in the local community (vehicle collisions, etc.) and the least threat to the respondents' own economic well-being (agriculture, personal property).

Landowners and local residents believed that there would potentially be moderate to high potential benefits from restoring elk within the study areas. Respondents were neither certain nor uncertain about the potential risks and benefits of restoring elk within the study areas. Landowners and local residents were perceived that they would have moderate personal control to limit risk to themselves if elk are restored within the study areas in Minnesota. Landowners believed that they would have little control to limit elk damage to their own agricultural and personal property or trees and forest vegetation. Landowners also believed that they would have little control to limit impact to deer and other wildlife in the study areas. Landowners and local residents believed that they would have little control to influence elk management decisions in the study areas.

Knowledge about Elk in Minnesota

Landowners and local residents were asked three questions to estimate their knowledge of elk in Minnesota. Each question contained a factual statement about elk in Minnesota and respondents were asked whether they knew this information prior to receiving the questionnaire. On average, landowners and local residents had moderate knowledge of elk in Minnesota. Hunters were more knowledge about elk in Minnesota than non-hunters among landowners and local residents. On average, hunters had moderate knowledge of elk in Minnesota and non-hunters had low knowledge.

Importance of Elk in Minnesota

Landowners and local residents were asked three questions to indicate the importance to the respondent of restoring wild, free-ranging elk to the study areas in Minnesota. A majority of landowners (64%) and local residents (69%) agreed with the statement "it is important that Minnesota someday have an abundant elk population within the study areas." A majority of landowners (70%) and local residents (76%) also agreed with the statement "whether or not I would get to see an elk, it is important to me that they could exist within the study areas." Most landowners (73%) and local residents (79%) also agreed with the statement "it is important to establish elk populations within the study areas so future generations can enjoy them."

Trust in Wildlife Managers

Respondents were asked to rate their agreement with three statements addressing their trust in wildlife managers. On average, landowners and local residents had similar levels of agreement for each trust statement, though only slightly agreed with each statement. Landowners and local residents agreed most with the statement that wildlife managers would be open and honest in the things they do and say when making elk management decisions. Non-hunters were more trusting of wildlife managers than hunters among landowners and local residents. Among landowners, non-farmers were more trusting of wildlife managers than farmers, though both groups only slightly agreed with each trust statement.

Elk-Related Recreation

Respondents were asked about interest in participating in elk-related recreation if an elk population is restored to the study areas in Minnesota, including wildlife viewing and hunting. A majority of landowners (61%) and local residents (64%) indicated that they would likely make a trip to view, photograph or hear elk within the study areas in Minnesota. Over 40% of landowners (46%) and local residents (41%) indicated that they had ever visited a National Park or similar destination in North America for which an important part of the trip was viewing, photographing or hearing elk.

Landowners and local residents were asked whether they have hunted elk or applied for an elk license in Minnesota or elsewhere in North America. Few landowners (2%) and local residents (0.2%) have applied for or have been drawn for an elk hunting license in Minnesota, although more respondents have hunted elk or applied to hunt elk elsewhere in North America (landowners: 21%; local residents: 8%). About one-quarter of landowners (24%) and but fewer than 1 in 5 local residents (16%) indicated that they plan to apply for a Minnesota elk hunting license in the future. A majority of landowners (52%) and local residents (71%) did not plan to apply for a Minnesota elk hunting license in the future. In general, landowners were more likely than local residents to have applied for or have drawn an elk license or apply for one in the future. About 1 in 10 landowners (10%) and local residents (12%) indicated that they have lived in an area where elk where common.

Outdoor Activities and Membership

Respondents were asked about their participation in outdoor recreation during the past 12 months. Among landowners, the greatest proportion of respondents participated in: (1) fishing (68%), (2) deer hunting (63%), (3) ATV riding (60%), and (4) hiking (60%). Among local residents, the greatest proportion of respondents participated in: (1) hiking (67%), (2) fishing (56%), (3) wildlife watching and photography (50%), and (4) feeding wildlife (41%).

Landowner Property Characteristics

Landowners were asked to describe their property within the study areas in Minnesota. Landowners that responded owned 94 acres on average with Fond du Lac landowners having the largest property sizes (Cloquet Valley: $\bar{x}$ = 72.2; Fond du Lac: $\bar{x}$ = 113.2; Nemadji: $\bar{x}$ = 97.3 acres). Most landowners indicated their property was used primarily as their primary residence (49%) or seasonal/recreational residence (47%). A majority of properties within the Nemadji study area were considered seasonal/recreational residences (67%). Landowners that described their property as a seasonal or recreational residence spent about two months annually on the property and 45% indicated their full-time residence was in the 7-county Twin Cities metro (Hennepin, Ramsey, Dakota, Anoka, Washington, Scott, and Carver Counties).

Landowners were asked to indicate activities had occurred on their property within the past 5 years. The most common land use activities reported by respondents were: (1) hunting (78%); (2) residential use (55%); (3) timber production (23%); and (4) hay production (22%). Row crops (corn, beans) (6%), small grains (wheat, oats) (6%), and commercial/Industrial use (2%) were the least common activities.

When asked about current uses, a majority of respondents indicated that at least some of their property was used for private residence, such as houses, lawns, and associated buildings (62%). Woodlands, such as natural forest and tree plantings, were the most common habitat type with 84% of respondents indicating at least some of their property contained woodlands. One-quarter of respondents indicated that they improve wildlife habitat on their property by creating wildlife food plots (25%). Hayfields (28%) and livestock pasture (13%) were the most common agricultural land types among respondents. Small grains (6%), row crops (5%), and other property types (6%) were present on a limited number of properties.

Demographic Characteristics of Landowners and Local Residents

On average, landowners ($\bar{x}$ = 60 years) were older than local residents ($\bar{x}$ = 49 years), but both landowners and local residents reported having lived in Minnesota a majority of their lives (90% vs 87%). A majority of landowners were male (81%). Local resident respondents tended to be male (66%), but we weighted local residents to reflect a near 50/50 proportion of males and females as well as correcting the age distribution to reflect census information for the study areas. Overall, a majority of landowners (53%) and local residents (65%) have attended at least some college. On average, the household income of landowners was larger than local residents ($98,667 vs $77,839). While more than 20% of landowners reported at least some haying activities, less than 20% of landowners (17%) reported that at least a portion of their household income was derived from farming. Half of landowners (51%) and about 4 out of 10 local residents (42%) were raised primarily in a rural area as a youth, either on a farm or not.

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Introduction

Elk (*Cervus canadensis*) have historically ranged over most of the state of Minnesota but were functionally extirpated in the early 1900s due to overharvest and habitat loss (Hazard, 1982). Although two small populations have been restored to northwest Minnesota, they are currently managed at low levels to reduce human-wildlife conflict (Minnesota Department of Natural Resources [MNDNR], 2016). Forested areas of the state, however, might avoid some of these conflicts and see significant ecological and economic benefits from returning elk to the landscape. Re-establishing this keystone herbivore could help restore the state's traditional wildlife heritage, diversify the large mammal community, increase tourism from wildlife viewers, and eventually provide additional hunting opportunities. Additional benefits include adapting to future climate change through assisted dispersal of a climate hardy species like elk and protecting against unforeseen events which could lead to the extirpation of Minnesota's current small and isolated elk populations. Finally, a landscape actively managed for elk will benefit other species adapted to young forests and brushlands. Evidence from other eastern states indicates elk restoration can be successful, but success is dependent on active forest management and public support for elk by local communities (Larkin, Cox, Wichrowski, Dzialak, & Maehr, 2004; Maehr, Noss, & Larkin, 2001; Popp, Toman, Mallory, & Hamr, 2014).

Understanding the public's attitudes and acceptance of elk and their potential impacts are key components of assessing the viability of elk restoration. Long-term management of elk will require an adaptive impact approach in which management objectives and strategies are guided by the preferences of the impacted public. The University of Minnesota, in collaboration with the Fond du Lac Band of Lake Superior Chippewa, conducted a self-administered mail-back questionnaire of landowners and local residents in northeastern Minnesota to determine their attitudes toward restoring an elk population. We surveyed 4,500 private landowners and 4,000 local residents in northeastern Minnesota to describe landowner and local resident attitudes toward potentially restoring an elk population to northeastern Minnesota.

Study Purpose and Objectives

The goal of this study was to understand the attitudes of private landowners and local residents toward potentially restoring elk to northeastern Minnesota. Specific objectives were to:

1) Understand citizens' attitudes toward elk and elk restoration;
2) Acceptance and tolerance of potential elk impacts;
3) Preference for management objectives concerning elk restoration including elk population size and geographic distribution; and
4) Preferences for management strategies to address potential conflicts with elk.

Methods

Study Area

The populations of interest in this study included private landowners and local residents within the study area that covered portions of Carlton, Pine, and St. Louis Counties. Three potential restoration areas for

elk were identified based on recommendations from local natural resource professionals. These areas were selected due to abundant public land, while minimizing potential conflict from other land uses (e.g., agriculture). The land cover types present within these counties were primarily deciduous and mixed forest, along with wetland and grasslands occurring less frequently. Based on the 2010 U.S. Census, the median age of respondents within these counties was approximately 41 years old with a nearly equal gender distribution (50.8% male, 49.2% female) and a majority identifying as racially white (92.4%) (U.S. Census Bureau, 2018).

Sampling

Three study areas were defined for landowners by creating a five mile buffer around each potential restoration area. The three study areas for the landowner survey included: (1) Cloquet Valley State Forest in St. Louis County, (2) Fond du Lac State Forest and Fond du Lac Indian Reservation in St. Louis and Carlton Counties, and (3) Nemadji State Forest in Pine County (Figure I-1). Local residents were stratified using four study areas matched to census blocks that correspond to county boundaries and major landmarks (e.g., roads, rivers). The four study areas for the local resident survey include: (1) southern St. Louis County south of the St. Louis River, (2) Carlton County, (3) northern Pine County north of Minnesota Highway 48, and (4) city of Duluth and the surrounding suburbs. We obtained the sample from a commercial vendor (https://www.m-s-g.com/Pages/genesys/), that used digitized maps we provided of the studies areas to define a sampling frame of households within census blocks that corresponded to the study areas.

A random stratified sample was used for private landowners within five miles of the restoration areas (n = 4,500). Landowner data were obtained using parcel ownership information from county tax records. The sample was stratified by the total number of acres owned by the landowner within the study area: (1) 10 to 40 acres, and (2) >40 acres. A stratified random sample was used for local residents (n = 4,000) within four study areas using contact information for households obtained from a third-party vendor.

Data Collection

Data were collected using a self-administered mail-back questionnaire based on an adapted Tailored Design Method (Dillman, Smyth, & Christian, 2014). Survey recipients were contacted three times between February and June 2018 using a full-length questionnaire for landowners (Appendix A) and local residents (Appendix B). In the initial contact, a personalized cover letter, survey questionnaire, and business-reply envelope were mailed to all potential study participants. The personalized cover letter explained the purpose of the study and asked recipients to complete and return the questionnaire. Approximately one month later, a second letter with another copy of the survey and business-reply envelope was sent to study participants who had not responded to the first mailing and had valid mailing addresses. Approximately two months after the second mailing, a third mailing that included a personalized cover letter and replacement questionnaire with business-reply envelope was sent to all individuals with valid addresses that had yet to reply. The 1st and 3rd mailings included an incentive ($2 and $1, respectively) to increase the likelihood of survey completion. Due to a lagging response rate, a fourth questionnaire with a $1-incentive was sent to local residents within the Carlton (n = 563) and Duluth study areas (n = 500). A shortened version of the questionnaire was mailed to non-respondents in June 2018 to serve as a non-response check for landowners (Appendix C) and local residents (Appendix

D). We did not send the shortened non-response survey to Carlton or Duluth because they were sent a full-length survey during this 4th mailing.

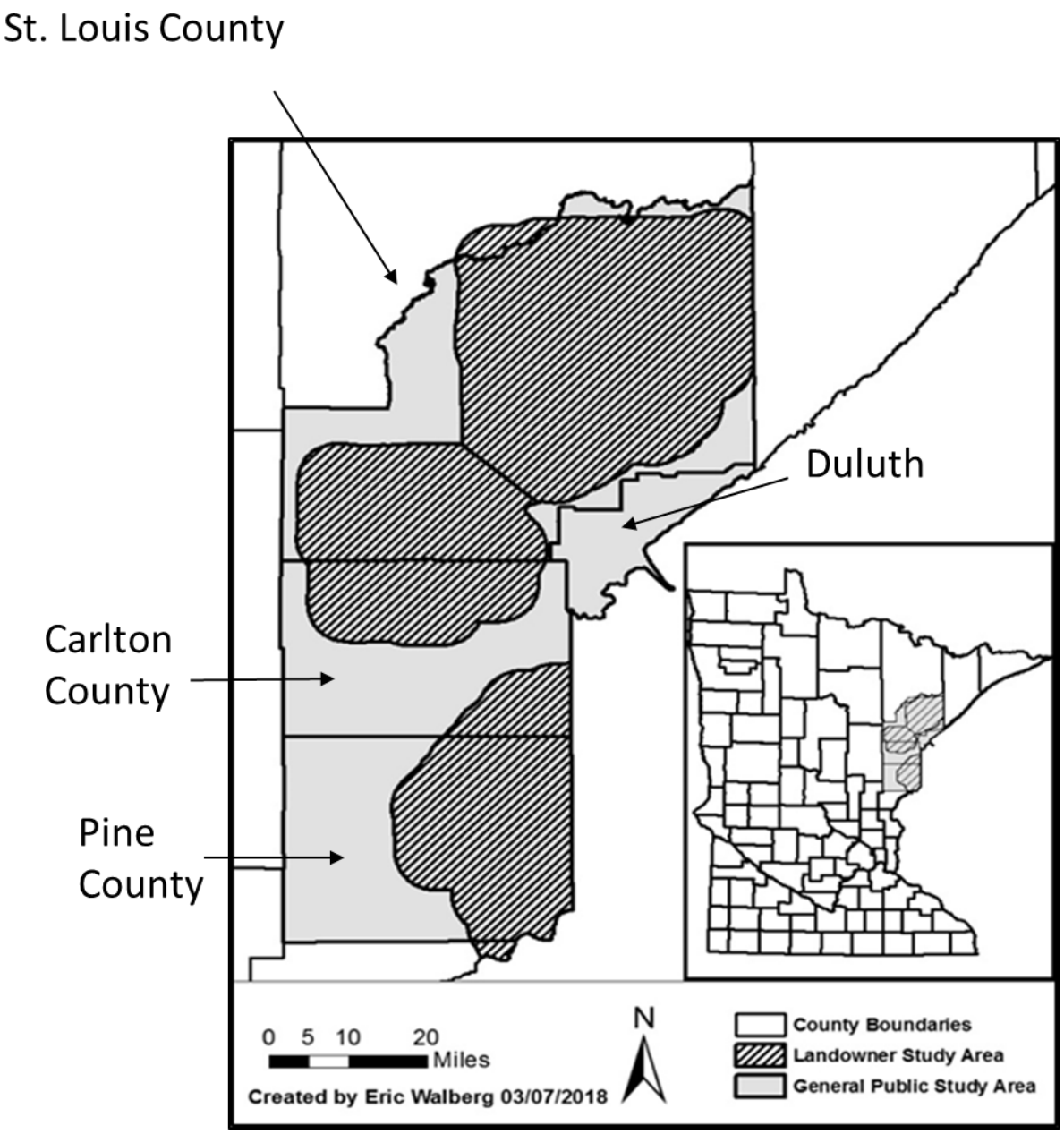

Figure I-1. Study area in northeastern Minnesota. The area includes portions of Carlton, Pine, and St. Louis Counties. Data were collected from a stratified, random sample of 4,500 landowners and 4,000 local residents.

Survey Instrument

The data collection instrument was a 12-page self-administered questionnaire with 11 pages of questions and a title page. Landowners (Appendix A) and local residents (Appendix B) were provided different versions of the questionnaire. The questionnaire addressed the following topics:

Section 1: Attitudes toward and support for elk restoration
Section 2: Importance of issues related to elk restoration
Section 3: Benefits and risks of restoring elk
Section 4: Knowledge about elk in Minnesota
Section 5: Importance of elk in Minnesota
Section 6: Trust in wildlife managers
Section 7: Elk-related recreation
Section 8: Outdoor activities and membership
Section 9: Landowners property characteristics
Section 10: Demographic characteristics of landowners and local residents

Data Entry and Analysis

Data were entered using REDCap electronic tools hosted at the University of Minnesota (Harris et al., 2009). Data were analyzed using program R (Version 3.5.2, www.r-project.org, accessed 29 March 2019). We computed descriptive statistics and frequencies within each study group. Results between landowners and local residents were not combined. Questionnaires returned after August 2018 were excluded from our analyses.

Survey Response Rate

Of the 4,500 questionnaires mailed to private landowners, 221 were undeliverable or otherwise invalid. Of the remaining 4,279 surveys, a total of 2,550 were returned, resulting in an overall response rate of 59.6%. An additional 338 shortened non-response surveys, used to gauge nonresponse bias, were returned for a total response rate of 67.5%. Respondents within the Cloquet Valley study area completed 841 full-length surveys (58.7%) and 110 non-response surveys (66.4%). Respondents within the Fond du Lac study area completed 797 full-length surveys (55.9%) and 116 non-response surveys (64.1%). Respondents within the Nemadji study area completed 912 full-length surveys (64.2%) and 112 non-response surveys (72.1%).

Of the 4,000 questionnaires mailed to local residents, 566 were undeliverable or otherwise invalid. Of the remaining 3,434 surveys, a total of 1,574 were returned, resulting in an overall response rate of 45.8%. An additional 120 shortened non-response surveys were returned for a total response rate of 49.3%. Respondents within the Carlton study area completed 373 full-length surveys (42.1%). Respondents within the Duluth study area completed 359 full-length surveys (43.3%). Instead of a non-response survey, participants in Carlton and Duluth were sent full-length surveys. Respondents within the Pine study area completed 393 full-length surveys (46.6%) and 66 non-response surveys (54.4%). Respondents within the St. Louis study area completed 449 full-length surveys (51.4%) and 54 non-response surveys (57.6%). Response rates for each stratum are summarized in Table I-1.

Table I-1. Survey response rate.

	Initial sample Size	Number invalid	Valid sample size	Full surveys completed	Full survey response rate	Non-response Survey	Total surveys returned	Total survey response rate
Landowners	**4,500**	**221**	**4,279**	**2,550**	**59.6%**	**338**	**2,888**	**67.5%**
Cloquet Valley	1,500	67	1,433	841	58.7%	110	951	66.4%
Fond du Lac	1,500	75	1,425	796	55.9%	116	913	64.1%
Nemadji	1,500	79	1,421	913	64.2%	112	1,024	72.1%
Local Residents	**4,000**	**566**	**3,434**	**1,574**	**45.8%**	**120**	**1,694**	**49.3%**
Carlton	1,000	113	887	373	42.1%	N/A	373	42.1%
Duluth	1,000	170	830	359	43.3%	N/A	359	43.3%
Pine	1,000	156	844	393	46.6%	66	459	54.4%
St. Louis	1,000	127	873	449	51.4%	54	503	57.6%
Total	**8,500**	**787**	**7,713**	**4,124**	**53.5%**	**458**	**4,582**	**59.4%**

Data Weighting

Because landowners were sampled using stratification within and across the study areas, we calculated two sets of weights to accurately reflect the actual population proportions (Vaske, 2008). First, we calculated weights within each study area (Cloquet Valley, Fond du Lac, and Nemadji) to reflect: 1) the population proportions of landowners in each study area who owned: (a) 10 to 40 acres; and (b) > 40 acres. Next, we calculated weights to correct for both the stratification of owned acres and the difference in the size of the landowner populations across the three study areas to obtain estimates at the overall study level. The weights applied at each level for landowners are summarized in Tables I-2 and I-3.

The general public data were weighted to reflect the population proportions in the four study areas (Carlton County, northern Pine County, southern St. Louis County, and Duluth) as well as to correct for gender and age distribution differences between the study populations in these areas and the sample of respondents. (We used information from the US census database to calculate weights that is available at: https://censusreporter.org/). As with landowners, we calculated two sets of weights. The first set of weights corrected for oversampling of males and older respondents compared to the study populations within each of the four study areas, and the second set of weights corrected for gender and age distributions as well as the population proportion across each study area. The two sets of weights are summarized in Tables I-4 through I-7.

Nonresponse check

We compared responses to the full-length survey (i.e., respondents) to those who responded to a shortened survey (i.e., non-respondents) to gauge nonresponse bias. A shortened one-page, two sided questionnaire was mailed to landowner and local resident non-respondents in June 2018. We did not find a significant difference between respondents to the questionnaire and non-respondents based on age and length of residence in Minnesota. Data were not weighted based on the non-response returns and results.

Table I-2. Weights for landowner estimates within study areas.

	Population of landowners >10 acres			Returned Sample Surveys			Population Proportions within Study Areas		Sample Proportions within Study Areas		Weights for estimates within study areas	
	N	10 to 40 acres	>40 acres	Total Surveys	10 to 40 acres	>40 acres	10 to 40 acres	>40 acres	10 to 40 acres	>40 acres	10 to 40 acres	>40 acres
Landowners	**9284**	**5119**	**4165**	**2,550**	**1197**	**1353**						
Cloquet Valley	3205	1838	1367	841	404	437	0.573	0.427	0.480	0.520	1.194	0.821
Fond du Lac	3271	1808	1463	796	360	436	0.553	0.447	0.452	0.548	1.222	0.816
Nemadji	2808	1473	1335	913	433	480	0.525	0.475	0.475	0.525	1.106	0.904

Table I-3. Weights for landowner estimates across study areas.

	Population of landowners >10 acres			Returned Sample Surveys			Population Proportions across Study Areas		Sample Proportions across Study Areas		Weights for estimates across study areas	
	N	10 to 40 acres	>40 acres	Total Surveys	10 to 40 acres	>40 acres	10 to 40 acres	>40 acres	10 to 40 acres	>40 acres	10 to 40 acres	>40 acres
Landowners	**9284**	**5119**	**4165**	**2,550**	**1197**	**1353**						
Cloquet Valley	3205	1838	1367	841	404	437	0.198	0.147	0.158	0.171	1.250	0.859
Fond du Lac	3271	1808	1463	796	360	436	0.195	0.158	0.141	0.171	1.379	0.922
Nemadji	2808	1473	1335	913	433	480	0.159	0.144	0.170	0.188	0.934	0.764

Table I-4. Weights for general public estimates within and across study areas (Carlton).

Study Areas Carlton	Population	% within strata	% total study area	Sample[1]	% within strata sample	% total study area sample	Weight within strata	Weight total study area
Total Study	N = 140475			n=1480				
Carlton	N = 26586		0.189	n=348		0.235		
Male:	13899	0.523	0.099	221	0.635	0.149		
20 to 29 years	2165	0.081	0.015	9	0.026	0.006	3.149	2.534
30 to 39 years	2528	0.095	0.018	23	0.066	0.016	1.439	1.158
40 to 49 years	2457	0.092	0.017	33	0.095	0.022	0.975	0.784
50 to 59 years	2837	0.107	0.020	54	0.155	0.036	0.688	0.554
60 to 69 years	2296	0.086	0.016	60	0.172	0.041	0.501	0.403
70 to 79 years	956	0.036	0.007	24	0.069	0.016	0.521	0.420
80 years and over	660	0.025	0.005	18	0.052	0.012	0.480	0.386
Female:	12687	0.477	0.090	127	0.365	0.086		
20 to 29 years	1737	0.065	0.012	6	0.017	0.004	3.789	3.050
30 to 39 years	2022	0.076	0.014	15	0.043	0.010	1.764	1.420
40 to 49 years	2079	0.078	0.015	24	0.069	0.016	1.134	0.913
50 to 59 years	2563	0.096	0.018	32	0.092	0.022	1.048	0.844
60 to 69 years	2078	0.078	0.015	26	0.075	0.018	1.046	0.842
70 to 79 years	1178	0.044	0.008	15	0.043	0.010	1.028	0.827
80 years and over	1030	0.039	0.007	9	0.026	0.006	1.498	1.206

[1]Sample sizes represent respondents that provided both gender and age information on their returned surveys.

Table I-5. Weights for general public estimates within and across study areas (Duluth).

Study Areas Duluth	Population	% within strata	% total study area	Sample[1]	% within strata sample	% total study area sample	Weight within strata	Weight total study area
Total Study	N=140475			n=1480				
Duluth	N=82729		0.589	n=337		0.228		
Male:	40936	0.495	0.291	198	0.588	0.134		
20 to 29 years	10941	0.132	0.078	14	0.042	0.009	3.183	8.234
30 to 39 years	6568	0.079	0.047	24	0.071	0.016	1.115	2.883
40 to 49 years	6091	0.074	0.043	24	0.071	0.016	1.034	2.674
50 to 59 years	6940	0.084	0.049	44	0.131	0.030	0.643	1.662
60 to 69 years	5718	0.069	0.041	57	0.169	0.039	0.409	1.057
70 to 79 years	2821	0.034	0.020	23	0.068	0.016	0.500	1.292
80 years and over	1857	0.022	0.013	12	0.036	0.008	0.630	1.630
Female:	41793	0.505	0.298	139	0.412	0.094		
20 to 29 years	9735	0.118	0.069	15	0.045	0.010	2.644	6.838
30 to 39 years	5881	0.071	0.042	13	0.039	0.009	1.843	4.766
40 to 49 years	5961	0.072	0.042	22	0.065	0.015	1.104	2.855
50 to 59 years	7368	0.089	0.052	23	0.068	0.016	1.305	3.375
60 to 69 years	6133	0.074	0.044	29	0.086	0.020	0.861	2.228
70 to 79 years	3494	0.042	0.025	23	0.068	0.016	0.619	1.601
80 years and over	3221	0.039	0.023	14	0.042	0.009	0.937	2.424

[1]Sample sizes represent respondents that provided both gender and age information on their returned surveys.

Table I-6. Weights for general public estimates within and across study areas (Pine).

Study Areas Pine	Population	% within strata	% total study area	Sample[1]	% within strata sample	% total study area sample	Weight within strata	Weight total study area
Total Study	N=140475			n=1480				
Pine	N=13546		0.096	n=373		0.252		
Male:	7458	0.551	0.053	248	0.665	0.168		
20 to 29 years	1018	0.075	0.007	3	0.008	0.002	9.344	3.575
30 to 39 years	1288	0.095	0.009	23	0.062	0.016	1.542	0.590
40 to 49 years	1340	0.099	0.010	29	0.078	0.020	1.272	0.487
50 to 59 years	1601	0.118	0.011	49	0.131	0.033	0.900	0.344
60 to 69 years	1124	0.083	0.008	79	0.212	0.053	0.392	0.150
70 to 79 years	734	0.054	0.005	50	0.134	0.034	0.404	0.155
80 years and over	353	0.026	0.003	15	0.040	0.010	0.648	0.248
Female:	6088	0.449	0.043	125	0.335	0.084		
20 to 29 years	773	0.057	0.006	2	0.005	0.001	10.643	4.072
30 to 39 years	786	0.058	0.006	18	0.048	0.012	1.202	0.460
40 to 49 years	982	0.072	0.007	18	0.048	0.012	1.502	0.575
50 to 59 years	1336	0.099	0.010	28	0.075	0.019	1.314	0.503
60 to 69 years	1117	0.082	0.008	33	0.088	0.022	0.932	0.357
70 to 79 years	779	0.058	0.006	21	0.056	0.014	1.021	0.391
80 years and over	315	0.023	0.002	5	0.013	0.003	1.735	0.664

[1]Sample sizes represent respondents that provided both gender and age information on their returned surveys.

Table I-7. Weights for general public estimates with and across study areas (St. Louis).

Study Areas St. Louis	Population	% within strata	% total study area	Sample[1]	% within strata sample	% total study area sample	Weight within strata	Weight total study area
Total Study	N=140475			n=1480				
St. Louis	N=17614	1.000	0.125	n=422	1.000	0.285		
Male:	9414	0.534	0.067	323	0.765	0.218		
20 to 29 years	962	0.055	0.007	6	0.014	0.004	3.841	1.689
30 to 39 years	1274	0.072	0.009	25	0.059	0.017	1.221	0.537
40 to 49 years	1457	0.083	0.010	34	0.081	0.023	1.027	0.451
50 to 59 years	2368	0.134	0.017	87	0.206	0.059	0.652	0.287
60 to 69 years	2118	0.120	0.015	101	0.239	0.068	0.502	0.221
70 to 79 years	937	0.053	0.007	54	0.128	0.036	0.416	0.183
80 years and over	298	0.017	0.002	16	0.038	0.011	0.446	0.196
Female:	17614	1.000	0.125	422	1.000	0.285		
20 to 29 years	9414	0.534	0.067	323	0.765	0.218		
30 to 39 years	962	0.055	0.007	6	0.014	0.004	3.841	1.689
40 to 49 years	1274	0.072	0.009	25	0.059	0.017	1.221	0.537
50 to 59 years	1457	0.083	0.010	34	0.081	0.023	1.027	0.451
60 to 69 years	2368	0.134	0.017	87	0.206	0.059	0.652	0.287
70 to 79 years	2118	0.120	0.015	101	0.239	0.068	0.502	0.221
80 years and over	937	0.053	0.007	54	0.128	0.036	0.416	0.183

[1]Sample sizes represent respondents that provided both gender and age information on their returned surveys.

Section 1. Understanding Support for Elk Restoration

We wanted to assess landowners' and local residents' level of support for restoration of a wild, free-ranging elk population to the study areas in northeastern Minnesota. In addition, we wanted to understand the specific attitudes and beliefs about the outcomes of restoring an elk population, and how these attitudes and beliefs are related to support for elk restoration. Primarily, we used an approach well-developed within social psychological research for understanding attitudes and their influence on behavior as outlined by Fishbein and Ajzen (2010) that has been used to study other wildlife management issues (Schroeder et al. 2016, Fulton et al. 2004, Whittaker et al. 2001).

Support for Elk Restoration

To assess support for elk restoration, we asked landowners and local residents how likely are unlikely they are to support restoring wild, free-ranging elk to the study areas or in Minnesota in general. A 7-point scale ranging from "very unlikely" (1) to "very likely" (7) was used to determine support for restoring elk. A majority of landowners (78%) and local residents (78%) indicated that they would likely support restoring wild, free-ranging elk to Minnesota in general (Table 1-1). Support for restoring elk to Minnesota varied significantly between strata for landowners ($F = 4.89$, $p < .01$) but not for local residents ($F = 2.12$, *n.s.*). A large majority of landowners and local residents were supportive within each stratum, with landowner support lowest in Fond du Lac (75%) and highest in Cloquet Valley (80%). Among local residents support was highest in Duluth (80%) and lowest in Carlton County (72%).

Table 1-1. Support for restoring wildlife, free-ranging elk to Minnesota in general.

	n	Very Unlikely						Very Likely	Mean[2]	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,491**	**6.1%**	**2.7%**	**2.6%**	**10.7%**	**12.3%**	**25.0%**	**40.7%**	**5.6**	
Cloquet Valley	824	6.3%	1.6%	2.5%	9.8%	12.5%	24.2%	43.1%	5.6	F = 4.89**
Fond du Lac	770	6.0%	4.2%	2.9%	12.5%	12.5%	26.3%	35.8%	5.4	η^2 = .004
Nemadji	897	5.9%	2.3%	2.2%	9.6%	11.9%	24.4%	43.6%	5.7	
Local Residents	**1,546**	**4.5%**	**2.4%**	**1.9%**	**13.3%**	**15.3%**	**27.8%**	**34.8%**	**5.6**	
Carlton	363	6.3%	4.1%	1.9%	15.4%	16.0%	21.5%	34.7%	5.3	
Duluth	354	3.1%	2.0%	2.0%	13.0%	15.5%	30.2%	34.2%	5.6	F = 2.12 n.s.
Pine	388	4.9%	2.8%	1.5%	14.1%	12.6%	28.2%	35.9%	5.6	
St Louis	442	6.5%	2.0%	1.8%	10.8%	14.9%	25.5%	38.4%	5.6	

[1]All results reflect weighted values correcting for stratification, gender, and age.

[2] Mean based on scale: 1 = very unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = unsure, 5 = slightly likely, 6 = quite likely, 7 = very likely

F compares strata within study areas.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Similarly, over three-quarters of landowners (80%) and local residents (81%) would likely support restoring wild, free-ranging elk to the study areas in northeastern Minnesota (Table 1-2). Support for restoring elk to the study areas in northeastern Minnesota varied significantly between strata for landowners ($F = 8.51$, $p < .001$) and local residents ($F = 3.55$, $p < .05$) although a large majority (>70%) of landowners and local residents were supportive within each stratum. On average, landowners within the Fond du Lac strata (75%) and local residents within Carlton County (75%) and Pine County (78%) were only slightly less likely to support restoring elk to the study areas in northeastern Minnesota than other respondents (>80%).

Table 1-2. Support for restoring wild, free-ranging elk to the study areas in Minnesota.

	n	Very Unlikely						Very Likely	Mean[2]	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,472**	**6.6%**	**2.9%**	**2.4%**	**8.7%**	**12.0%**	**24.6%**	**42.9%**	**5.6**	
Cloquet Valley	815	6.3%	1.7%	2.5%	7.4%	12.4%	24.4%	45.5%	5.7	F = 8.51 ***
Fond du Lac	763	7.6%	4.1%	2.2%	11.3%	12.2%	25.8%	36.9%	5.4	η^2 = .007
Nemadji	894	5.9%	2.9%	2.5%	7.3%	11.4%	23.4%	46.6%	5.7	
Local Residents	**1,531**	**4.7%**	**2.2%**	**2.3%**	**10.1%**	**15.3%**	**28.4%**	**37.0%**	**5.6**	
Carlton	358	7.0%	3.1%	3.4%	11.5%	17.9%	21.3%	35.9%	5.4	
Duluth	350	3.1%	2.0%	2.3%	10.3%	16.0%	30.0%	36.3%	5.7	F = 3.55*
Pine	382	4.7%	3.1%	1.0%	12.9%	11.5%	27.6%	39.1%	5.6	η^2 = .007
St Louis	441	7.0%	1.1%	1.4%	7.9%	9.8%	31.3%	41.5%	5.7	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2] Mean based on scale: 1 = very unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = unsure, 5 = slightly likely, 6 = quite likely, 7 = very likely
F compares strata within study area.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Landowners were also asked whether they would be unlikely or likely to support restoring wild, free-ranging elk on their own property or within five miles of their own property. A majority of landowners indicated that they would likely support restoring elk within five miles of their property (76%) (Table 1-3) or on their property (70%) (Table 1-4). Support for restoring elk within five miles of ($F = 7.51$, $p < .001$) or on their own property ($F = 6.27$, $p < .01$) varied significantly between strata, although a majority of respondents were supportive within each stratum. On average, landowners within the Fond du Lac strata were less likely to support restoring elk on the respondents' property or within five miles than landowners in the other two study areas, but even in the Fond du Lac study area 73% supported restoring elk within 5 miles of their property and 67% supported restoring elk on their property.

Table 1-3. Support for restoring wild, free-ranging elk within five miles of respondents' property.

	n	Very Unlikely						Very Likely	Mean[2]	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,472**	**9.0%**	**2.8%**	**2.7%**	**9.3%**	**10.3%**	**23.1%**	**42.8%**	**5.5**	
Cloquet Valley	816	8.2%	2.3%	2.8%	9.2%	10.3%	22.2%	45.0%	5.5	F = 7.51 ***
Fond du Lac	766	10.4%	3.5%	2.6%	10.7%	11.6%	24.4%	36.7%	5.3	η^2 = .006
Nemadji	890	8.4%	2.4%	2.7%	7.6%	8.8%	22.7%	47.5%	5.6	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2] Mean based on scale: 1 = very unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = unsure, 5 = slightly likely, 6 = quite likely, 7 = very likely
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 1-4. Support for restoring wild, free-ranging elk on respondents' property.

	n	Very Unlikely						Very Likely	Mean[2]	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,474**	**11.7%**	**3.3%**	**3.2%**	**11.8%**	**8.5%**	**20.6%**	**40.8%**	**5.3**	
Cloquet Valley	817	10.4%	3.4%	2.7%	12.4%	9.1%	19.6%	42.3%	5.3	F = 6.27 **
Fond du Lac	764	13.5%	3.5%	4.1%	12.4%	9.8%	21.0%	35.7%	5.1	η^2 = .005
Nemadji	893	11.1%	2.9%	2.9%	10.5%	6.4%	21.3%	44.9%	5.4	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2] Mean based on scale: 1 = very unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = unsure, 5 = slightly likely, 6 = quite likely, 7 = very likely
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Attitudes toward Elk Restoration in Study Areas of Northeastern Minnesota

Following standard procedures that are well-developed and tested within social psychological research (Fishbein & Ajzen 2010), we assessed respondents' attitudes toward supporting elk restoration in the study areas of northeast Minnesota using four questions. First, respondents were asked to describe their feelings about potentially restoring wild, free-ranging elk within the study areas in northeastern Minnesota (Table 1-5). Responses were measured on a 7-point scale ranging from "very unfavorable" (1) to "very favorable" (7). Three-quarters of landowners (76%) and 8 out of 10 local residents (81%) had favorable attitudes toward potentially restoring elk. Among landowners, attitudes about restoring wild, free-ranging elk varied significantly between strata ($F = 4.05$, $p < .05$) although a majority of responses were favorable for each stratum. Among local residents, attitudes about restoring wild, free-ranging elk varied significantly between strata ($F = 4.49$, $p < .01$) although a majority of responses were favorable for each stratum.

Table 1-5. Feelings about potentially restoring wild, free-ranging elk within the study areas in Minnesota.

	n	Very Unfavorable	Moderately Unfavorable	Slightly Unfavorable	Neutral	Slightly Favorable	Moderately Favorable	Very Favorable	Mean[1]	ANOVA
Landowners	**2,506**	**8.8%**	**3.4%**	**2.3%**	**9.7%**	**6.6%**	**17.4%**	**51.6%**	**5.6**	
Cloquet Valley	828	8.6%	1.9%	2.2%	8.7%	6.5%	18.1%	54.0%	5.7	F = 4.05 * η^2 = .003
Fond du Lac	774	8.8%	5.0%	2.6%	11.1%	7.4%	18.1%	47.1%	5.4	
Nemadji	904	9.3%	3.2%	2.3%	9.3%	5.9%	16.0%	54.0%	5.6	
Local Residents	**1,558**	**5.4%**	**1.7%**	**1.5%**	**10.1%**	**5.6%**	**24.5%**	**51.1%**	**5.9**	
Carlton	365	9.0%	2.2%	2.5%	11.2%	5.8%	21.1%	48.2%	5.6	F = 4.49 ** η^2 = .010
Duluth	354	3.1%	0.8%	0.6%	11.0%	5.6%	27.7%	51.1%	6.0	
Pine	392	7.4%	2.0%	5.1%	10.9%	3.8%	21.6%	49.1%	5.6	
St Louis	447	8.3%	3.8%	0.9%	5.1%	5.8%	20.6%	55.5%	5.8	

[1]All results reflect weighted values correcting for stratification, gender, and age.

[2] Mean based on scale: 1 = very unfavorable, 2 = moderately unfavorable, 3 = slightly unfavorable, 4 = neutral, 5 = slightly favorable, 6 = moderately favorable, 7 = very favorable

F compares strata within each study area.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

In addition, we asked, landowners and local residents whether supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is negative/positive, harmful/beneficial, or bad/good. A 7-point scale from "very negative" (1) to "very positive" (7) was used for beliefs about supporting an elk restoration. On average, landowners ($\bar{x}$ = 5.6) and local residents ($\bar{x}$ = 5.9) believed supporting the restoration of an elk population is positive (Table 1-6). Over 70% of landowners (71%) and local residents (74%) believed that supporting an elk restoration would be positive. Landowners' belief that supporting an elk restoration would be negative or positive varied significantly between strata (F = 8.35, $p < .001$), but 65% of landowners or more were felt it would be positive in each study area. Local residents' beliefs that supporting an elk restoration would be negative or positive also varied significantly between strata (F = 5.12, $p < .001$), but 70% or more felt elk restoration would be positive in each area.

Table 1-6. Evaluation of supporting the restoration of a wild, free-ranging elk population in study areas in Minnesota as negative or positive.

	n	Very negative	Quite negative	Slightly negative	Neither	Slightly positive	Quite positive	Very positive	Mean[2]	ANOVA
Landowners	**2,454**	**5.0%**	**2.7%**	**5.0%**	**16.0%**	**12.0%**	**23.0%**	**36.4%**	**5.4**	
Cloquet Valley	815	4.4%	2.3%	3.6%	15.5%	12.4%	23.4%	38.4%	5.5	F = 8.35 ***
Fond du Lac	761	5.5%	3.7%	6.7%	17.7%	13.4%	20.2%	32.8%	5.2	η^2 = .007
Nemadji	878	5.0%	1.9%	4.9%	14.7%	9.9%	25.5%	38.1%	5.5	
Local Residents	**1,525**	**2.7%**	**1.2%**	**3.9%**	**18.7%**	**11.8%**	**29.2%**	**32.6%**	**5.5**	
Carlton	363	5.2%	1.4%	6.3%	19.8%	11.5%	27.7%	28.0%	5.3	
Duluth	351	1.4%	0.9%	3.1%	19.1%	10.8%	30.2%	34.5%	5.7	F = 5.12 ***
Pine	389	4.1%	2.1%	6.2%	16.5%	15.5%	26.0%	29.6%	5.3	η^2 = .012
St Louis	422	4.3%	1.2%	1.7%	15.7%	15.0%	28.5%	33.7%	5.6	

[1]All results reflect weighted values correcting for stratification, gender, and age.

[2] Mean based on scale: 1 = very negative, 2 = quite negative, 3 = slightly negative, 4 = neutral, 5 = slightly positive, 6 = quite positive, 7 = very positive

F compares strata within study areas.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

We also asked respondents if they believed supporting elk restoration would be harmful or beneficial using a 7-point scale from "very harmful" (1) to "very beneficial" (7). On average, landowners ($\bar{x}$ = 5.1) and local residents ($\bar{x}$ = 5.3) believed supporting the restoration of an elk population is beneficial (Table 1-7). Over 60% of landowners (63%) and 66% of local residents believed that supporting elk restoration would be beneficial. Landowners' belief that supporting an elk population would be harmful or beneficial varied significantly between strata (F = 8.55, $p < .001$), with 57% of Fond du Lac landowners believing restoration would be beneficial and 64% or more of landowners in both Cloquet Valley and Nemadji believing elk restoration would be beneficial. Less than 20% of landowners in all three study areas believed it would be harmful. Local residents' belief that supporting an elk restoration would be harmful or beneficial also varied significantly between strata (F = 6.59, $p < .001$), with Duluth residents (68%) most likely to see restoration as beneficial and Carlton residents (58%) least likely.

Table 1-7. Evaluation of supporting restoration of a wild, free-ranging elk population in study areas in Minnesota as harmful or beneficial.

	n	Very harmful	Quite harmful	Slightly harmful	Neither	Slightly beneficial	Quite beneficial	Very beneficial	Mean[2]	ANOVA
Landowners	**2,432**	**5.4%**	**3.6%**	**6.7%**	**21.9%**	**13.3%**	**19.1%**	**30.1%**	**5.1**	
Cloquet Valley	807	5.4%	2.8%	5.6%	19.7%	13.7%	19.8%	33.0%	5.2	F = 8.55 ***
Fond du Lac	752	5.9%	5.1%	7.2%	24.7%	13.8%	18.1%	25.3%	4.9	η^2 = .007
Nemadji	873	4.8%	2.7%	7.4%	21.1%	12.3%	19.5%	32.2%	5.2	
Local Residents	**1,522**	**2.9%**	**2.2%**	**4.6%**	**24.6%**	**14.8%**	**23.8%**	**27.0%**	**5.3**	
Carlton	359	6.2%	3.9%	5.9%	26.3%	16.0%	18.8%	23.0%	4.9	
Duluth	348	2.0%	1.2%	4.7%	23.8%	17.2%	22.1%	29.1%	5.4	F = 8.31***
Pine	387	6.5%	2.4%	8.4%	24.9%	13.9%	17.8%	26.2%	5.4	η^2 = .013
St Louis	428	4.0%	1.6%	4.7%	24.4%	15.2%	21.5%	28.6%	5.2	

[1]All results reflect weighted values correcting for stratification, gender, and age.

[2] Mean based on scale: 1 = very harmful, 2 = quite harmful, 3 = slightly harmful, 4 = neutral, 5 = slightly beneficial, 6 = quite beneficial, 7 = very beneficial

F compares strata within study areas.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Finally, we had respondents report with they believed elk restoration was bad or good, using a 7-point scale from "very bad" (1) to "very good" (7). On average, landowners ($\bar{x}$ = 5.3) and local residents ($\bar{x}$ = 5.4) believed supporting the restoration of an elk population is good (Table 1-8). Over 65% of landowners (66%) and local residents (68%) believed that supporting an elk population would be good. Landowners' beliefs that supporting an elk population would be bad or good varied significantly between strata (F = 9.98, $p < .001$), with a lower percentage of Fond du Lac landowners (62%) than Cloquet Valley (65%) or Nemadji (69%) landowners responding that restoration would be good. Local residents' beliefs that supporting an elk restoration would be bad or good also varied significantly between strata (F = 6.05, $p < .01$), with a larger percentage of Duluth (71%) and southern St. Louis County (68%) residents responding that restoration would be good compared to residents in Carlton (62%) or northern Pine (61%) counties.

Table 1-8. Evaluation of supporting restoration of a wild, free-ranging elk population in study areas in Minnesota as bad or good.[1]

	n	Very bad	Quite bad	Slightly bad	Neither	Slightly good	Quite good	Very good	Mean[2]	ANOVA
Landowners	**2,430**	**5.7%**	**3.2%**	**4.2%**	**20.6%**	**10.3%**	**20.5%**	**35.4%**	**5.3**	
Cloquet Valley	805	5.6%	2.6%	2.7%	21.1%	9.7%	20.0%	38.3%	5.4	F = 9.98 *** η^2 = .008
Fond du Lac	753	6.5%	4.1%	6.0%	21.5%	13.1%	18.1%	30.7%	5.1	
Nemadji	872	5.0%	2.8%	4.0%	19.0%	7.7%	24.0%	37.5%	5.4	
Local Residents	**1,519**	**3.2%**	**1.6%**	**3.3%**	**24.0%**	**9.8%**	**26.2%**	**31.8%**	**5.4**	
Carlton	358	5.9%	3.6%	4.8%	24.1%	10.1%	24.6%	26.9%	5.1	F = 6.05*** η^2 = .010
Duluth	346	2.0%	0.6%	2.9%	23.6%	9.5%	27.9%	33.6%	5.6	
Pine	387	4.1%	2.1%	5.9%	26.6%	11.4%	20.9%	28.9%	5.2	
St Louis	428	5.4%	2.6%	0.9%	23.2%	10.1%	25.5%	32.3%	5.4	

[1]All results reflect weighted values correcting for stratification, gender, and age.

[2] Mean based on scale: 1 = very bad, 2 = quite bad, 3 = slightly bad, 4 = neutral, 5 = slightly good, 6 = quite good, 7 = very good

F compares strata within study areas.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

We assessed whether the four items together formed a reliable scale for assessing attitudes toward elk restoration in the study areas and found that the three items summarized in Tables 1-6, 1-7. and 1-8 formed a more reliable scale for both landowners (Cronbach's $\alpha = 0.95$) and local residents (Cronbach's $\alpha = 0.94$) (Table 1-9) than a scale with all four items (Cronbach's $\alpha = 0.90$). For this reason, we created a scale consisting of mean score for each respondent on these three items to measure attitudes toward elk restoration in the study areas for subsequent analyses (Fishbein & Ajzen 2010).

Table 1-9. Reliability assessment of evaluative statements to measure attitudes toward supporting restoration of elk in study areas in Minnesota.[1,2]

	Corrected Item-total Correlation	Cronbach's Alpha	Cronbach's Alpha if Item Deleted	Mean
Landowners		.947		5.3
Would you say supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is negative or positive?	.860		.944	
Would you say supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is harmful or beneficial?	.889		.922	
Would you say supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is bad or good?	.918		.899	
Local Residents		.940		5.4
Would you say supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is negative or positive?	.833		.944	
Would you say supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is harmful or beneficial?	.885		.904	
Would you say supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is bad or good?	.909		.886	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2] Mean based on scale: 1 = very negative/harmful/bad, 2 = quite negative/harmful/bad, 3 = slightly negative/harmful/bad, 4 = neutral, 5 = slightly positive/beneficial/good, 6 = quite positive/beneficial/good, 7 = very positive/beneficial/good

Beliefs about Outcomes from Restoring an Elk Population

Landowners and local residents were presented with a series of 14 potential outcomes from restoring a wild, free-ranging elk population within the study areas in Minnesota and asked the likelihood of each outcome (Table 1-10). We used a 7-point scale from "very unlikely" (1) to "very likely" (7) to assess their beliefs about the likelihood of outcomes. Respondents believed that the most likely outcomes from restoring an elk population were: (1) provide opportunities to view elk, (2) restore a native wildlife species, and (3) provide opportunities to hunt elk. Respondents believed that the least likely outcomes from restoring an elk population were: (1) negatively impact other wildlife populations, (2) increase risk of disease transmission to livestock and wildlife, and (3) increase damage to trees and forest vegetation. Beliefs about the likelihood of each potential outcome were similar for landowners and local residents except increasing economic opportunities through elk-related tourism ($t = -5.06$, $p < .001$), increasing damage to agriculture and personal property ($t = 2.27$, $p < .05$), and increase damage to trees and forest vegetation ($t = 2.35$, $p < .05$).

Table 1-10. Beliefs about the likelihood of potential outcomes from restoring a wild, free-ranging elk population within the study areas in Minnesota.

	Group	N	Mean[1]
Increase youth involvement and interest in outdoors	Landowners	2,493	4.8
	Local Residents	1,550	4.9
Restore a native wildlife species	Landowners	2,491	5.5
	Local Residents	1,553	5.8
Increase economic opportunities through elk-related tourism	Landowners	2,486	4.8
	Local Residents	1,542	5.2
Provide opportunities to hunt elk	Landowners	2,479	5.2
	Local Residents	1,549	5.3
Increase damage to agriculture and personal property	Landowners	2,484	4.3
	Local Residents	1,549	4.0
Shift management focus from other wildlife species such as deer and moose	Landowners	2,486	4.1
	Local Residents	1,552	4.0
Conflict between elk and deer	Landowners	2,477	4.0
	Local Residents	1,552	3.9
Conflict between elk and moose	Landowners	2,484	3.8
	Local Residents	1,554	3.8
Negatively impact other wildlife populations	Landowners	2,485	3.5
	Local Residents	1,547	3.4
Increase conflict among people due to elk	Landowners	2,490	3.8
	Local Residents	1,551	3.5
Increase damage to trees and forest vegetation	Landowners	2,486	3.8
	Local Residents	1,554	3.7
Increase risk of disease transmission to livestock and wildlife	Landowners	2,488	3.7
	Local Residents	1,548	3.7
Increase cost to taxpayers	Landowners	2,487	4.2
	Local Residents	1,551	4.2
Provide opportunities to view elk	Landowners	2,492	5.5
	Local Residents	1,553	5.6

[1]All results reflect weighted values correcting for stratification, gender, and age.
Mean based on scale: 1 = very unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = unsure, 5 = slightly likely, 6 = quite likely, 7= very likely

Evaluation of Outcomes of Restoring an Elk Population

Landowners and local residents were presented with the same series of 14 possible outcomes from restoring a wild, free-ranging elk population within the study areas in Minnesota and asked how bad or good each outcome would be (Table 1-11). A 7-point scale from "very bad" (1) to "very good" (7) was used to evaluate potential outcomes from potentially restoring an elk population. Respondents evaluated five potential outcomes as good and the other nine to be bad, though each potentially bad outcome was, on average, considered to be only slightly bad. Respondents' believed that the best potential outcomes from restoring an elk population were: (1) restoring a native wildlife species, (2) increasing youth involvement and interest in the outdoors, and (3) providing opportunities to view elk. Respondents' believed that the worst potential outcomes were: (1) increasing risk of disease transmission to livestock and wildlife, (2) increasing costs to taxpayers, and (3) increasing damage to trees and forest vegetation. The evaluation of each potential outcome was similar for landowners and local residents except increasing economic opportunities through elk-related tourism ($t = -3.35$, $p < .001$) and providing opportunities to view elk ($t = -5.23$, $p < .001$).

Table 1-11. Evaluation of potential outcomes from restoring a wild, free-ranging elk population within the study areas in Minnesota as good or bad.

	Group	N	Mean[1]
Increase youth involvement and interest in outdoors	Landowners	2,462	5.5
	Local Residents	1,527	5.7
Restore a native wildlife species	Landowners	2,454	5.7
	Local Residents	1,524	5.9
Increase economic opportunities through elk-related tourism	Landowners	2,437	5.1
	Local Residents	1,519	5.5
Provide opportunities to hunt elk	Landowners	2,444	5.3
	Local Residents	1,507	5.3
Increase damage to agriculture and personal property	Landowners	2,439	3.6
	Local Residents	1,495	3.4
Shift management focus from other wildlife species such as deer and moose	Landowners	2,440	3.7
	Local Residents	1,504	3.8
Conflict between elk and deer	Landowners	2,442	3.7
	Local Residents	1,514	3.7
Conflict between elk and moose	Landowners	2,443	3.7
	Local Residents	1,514	3.6
Negatively impact other wildlife populations	Landowners	2,421	3.7
	Local Residents	1,508	3.5
Increase conflict among people due to elk	Landowners	2,429	3.6
	Local Residents	1,516	3.7
Increase damage to trees and forest vegetation	Landowners	2,439	3.6
	Local Residents	1,516	3.5
Increase risk of disease transmission to livestock and wildlife	Landowners	2,443	3.5
	Local Residents	1,517	3.3
Increase cost to taxpayers	Landowners	2,435	3.6
	Local Residents	1,515	3.5
Provide opportunities to view elk	Landowners	2,440	5.4
	Local Residents	1,511	5.7

[1]All results reflect weighted values correcting for stratification, gender, and age.
Mean based on scale: 1 = very bad, 2 = quite bad, 3 = slightly bad, 4 = neutral, 5 = slightly good, 6 = quite good, 7 = very good

Normative Beliefs about Other People/Groups Support for Restoring an Elk Population

Respondents were asked whether they believe people who are important to them believe that they should or should not support restoring a wild, free-ranging elk population within the study areas in Minnesota (Table 1-12). We used a 7-point scale ranging from "very much should not" (1) to "very much should" (7) to assess whether respondents' believe most people important to them believe they should support elk restoration in the study areas of northeastern Minnesota. Such beliefs are referred to as normative beliefs (Fishbein & Ajzen 2010). Over 70% of landowners (74%) and local residents (73%) indicated that most people important to them would believe that the respondent should support restoring an elk population. Landowners' responses varied significantly among strata ($F = 5.51$, $p < .01$) with Fond du Lac landowners (71%) perceiving the least support among people important to the respondent for restoring an elk population. Local residents' responses did not significantly vary among strata.

Table 1-12. At what level would most people important to the respondent think that they should or should not support restoring a wild, free-ranging within the study areas in Minnesota.

	n	Very much should not	Moderately should not	Slightly should not	Neither	Slightly should	Moderately should	Very much should	Mean[2]	ANOVA
Landowners	**2,472**	**5.0%**	**3.6%**	**2.4%**	**15.1%**	**11.9%**	**29.4%**	**32.5%**	**5.4**	
Cloquet Valley	819	4.4%	3.5%	2.0%	13.9%	11.2%	31.3%	33.7%	5.5	$F = 5.51$ **
Fond du Lac	772	5.4%	3.8%	2.3%	17.9%	13.9%	29.4%	27.2%	5.3	$\eta^2 = .004$
Nemadji	881	5.1%	3.4%	3.1%	13.3%	10.4%	27.2%	37.5%	5.5	
Local Residents	**1,546**	**2.6%**	**1.4%**	**1.8%**	**21.1%**	**14.0%**	**33.1%**	**26.1%**	**5.5**	
Carlton	365	3.8%	4.4%	2.7%	19.0%	17.3%	27.7%	25.0%	5.2	
Duluth	352	1.1%	0.6%	1.1%	23.3%	13.6%	35.2%	25.0%	5.5	$F = 2.34$ n.s.
Pine	390	3.8%	2.1%	2.3%	19.2%	9.5%	37.2%	25.9%	5.4	
St Louis	439	5.9%	1.1%	1.8%	16.4%	15.0%	28.2%	31.6%	5.4	

[1]All results reflect weighted values correcting for stratification, gender, and age.

[2] Mean based on scale: 1 = very much should not, 2 = moderately should not, 3 = slightly should not, 4 = neither, 5 = slightly should, 6 = moderately should, 7 = very much should

F compares strata within study areas.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Respondents also were asked whether they would be motivated to do what people who are important to them think that they should do regarding supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota (Table 1-13). A 7-point scale from "strongly disagree" (1) to "strongly agree" (7) was used to determine respondents' motivation to comply with the beliefs held by individuals important to the respondent. A majority of landowners (51%) agreed that they wanted to do what people important to them want the respondent to do regarding supporting the restoration of an elk population within the study areas in Minnesota, but only about 4 out of 10 (42%) local residents agreed with this statement. Landowners' and local residents' motivation to comply with the beliefs of people important to the respondent did not vary significantly between strata.

Table 1-13. Whether respondent wants to do what people important to them think they should do regarding supporting the restoration of wild, free-ranging elk population within the study areas in Minnesota.[1]

	n	Strongly disagree	Moderately disagree	Slightly disagree	Neither	Slightly agree	Moderately agree	Strongly agree	Mean[1]	ANOVA
Landowners	**2,438**	**8.5%**	**5.3%**	**3.4%**	**31.4%**	**13.5%**	**19.8%**	**18.0%**	**4.7**	
Cloquet Valley	811	8.8%	4.2%	3.7%	31.7%	13.7%	19.4%	18.6%	4.7	F = 0.38 n.s.
Fond du Lac	758	8.7%	5.6%	3.7%	31.2%	13.9%	20.8%	16.1%	4.6	
Nemadji	869	8.2%	6.3%	2.8%	31.2%	12.9%	19.2%	19.4%	4.7	
Local Residents	**1,525**	**9.0%**	**5.6%**	**4.5%**	**39.0%**	**13.1%**	**16.6%**	**12.2%**	**4.4**	
Carlton	361	10.8%	4.7%	5.0%	36.1%	13.6%	17.5%	12.2%	4.4	
Duluth	348	8.0%	6.0%	3.7%	41.4%	11.8%	16.7%	12.4%	4.4	F = 0.21 n.s.
Pine	384	9.6%	3.6%	9.6%	34.3%	13.8%	17.4%	11.7%	4.4	
St Louis	432	9.0%	6.7%	1.9%	37.3%	16.7%	16.2%	12.3%	4.4	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2] Mean based on scale: 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Respondents were presented with 12 categories of people/groups and were asked the likelihood that the people or group think the respondent should support restoring a wild, free-ranging elk population within the study areas in Minnesota (Table 1-14). Landowners and local residents believed that most hunters they know, local hunting organizations, and the MNDNR were most likely to believe that the respondent should support restoring an elk population with the study areas in Minnesota. Local farmers, livestock producers, and local agricultural groups were thought to be least likely to think that the respondent should support restoring an elk population. Respondents were also asked about the likelihood that they would do what the people or groups want them to do concerning supporting the restoration of an elk population within the study areas in Minnesota (Table 1-15). Respondents were most likely to do what their family, friends, and other hunters want concerning supporting the restoration of an elk population. Respondents

were least likely to do what local agricultural groups, the local timber industry, and local farmers and livestock producers want concerning supporting the restoration of an elk population.

Table 1-14. Likelihood that people/groups think respondent should support restoring a wild, free-ranging elk population within the study areas in Minnesota.

	Group	n	Mean[1]
Most of their family and friends	Landowners	2,460	5.3
	Local Residents	1,524	5.2
Most hunters they know	Landowners	2,460	5.4
	Local Residents	1,525	5.5
Most local hunting organizations	Landowners	2,444	5.3
	Local Residents	1,516	5.4
Most local government officials	Landowners	2,441	4.6
	Local Residents	1,520	4.5
Most local landowners	Landowners	2,451	4.5
	Local Residents	1,524	4.2
Minnesota DNR	Landowners	2,445	5.3
	Local Residents	1,520	5.4
Local farmers & livestock producers	Landowners	2,446	3.6
	Local Residents	1,525	3.7
Most local residents	Landowners	2,455	4.6
	Local Residents	1,520	4.7
Most of their neighbors	Landowners	2,452	4.8
	Local Residents	1,521	4.8
Local conservation/environmental organizations	Landowners	2,443	5.2
	Local Residents	1,515	5.3
Local timber industry	Landowners	2,447	4.3
	Local Residents	1,516	4.1
Local agricultural groups	Landowners	2,453	3.7
	Local Residents	1,523	3.8

[1]All results reflect weighted values correcting for stratification, gender, and age.
Mean based on scale: 1 = very unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = unsure, 5 = slightly likely, 6 = quite likely, 7 = very likely
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 1-15. Likelihood of landowner doing what people/groups want them to do concerning supporting an elk population in northwest Minnesota.

	Group	n	Mean[1]
Most of their family and friends	Landowners	2,384	4.6
	Local Residents	1,509	4.5
Most hunters they know	Landowners	2,387	4.5
	Local Residents	1,504	4.2
Most local hunting organizations	Landowners	2,373	4.3
	Local Residents	1,505	4.0
Most local government officials	Landowners	2,377	3.8
	Local Residents	1,503	3.6
Most local landowners	Landowners	2,375	4.1
	Local Residents	1,497	3.8
Minnesota DNR	Landowners	2,376	4.4
	Local Residents	1,499	4.3
Local farmers & livestock producers	Landowners	2,376	3.7
	Local Residents	1,499	3.7
Most local residents	Landowners	2,382	4.1
	Local Residents	1,502	3.9
Most of their neighbors	Landowners	2,372	4.2
	Local Residents	1,506	4.0
Local conservation/environmental organizations	Landowners	2,384	4.2
	Local Residents	1,504	4.2
Local timber industry	Landowners	2,379	3.7
	Local Residents	1,502	3.4
Local agricultural groups	Landowners	2,383	3.6
	Local Residents	1,500	3.5

[1]All results reflect weighted values correcting for stratification, gender, and age.
Mean based on scale: 1 = very unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = unsure, 5 = slightly likely, 6 = quite likely, 7 = very likely
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Relationship among Support for, Attitudes toward, Beliefs about the Outcomes of, and Normative Beliefs of Restoring an Elk Population

Based on results of regression analysis, attitudes toward and normative beliefs about restoration of a wild, free-ranging elk populations in the study areas are both strong predictors of actual support of elk restoration for both landowners ($R^2 = 0.63$; attitude $\beta = 0.36$, $p < 0.001$; normative beliefs $\beta = 0.47$, $p < 0.001$)) and local residents ($R^2 = 0.52$; attitude $\beta = 0.43$, $p < 0.001$; normative beliefs $\beta = 0.36$, $p < 0.001$) (Table 1-16). Following well-established research approaches on attitudes and beliefs (Fishbein & Ajzen 2010), we wanted to identify which beliefs about the outcomes of supporting elk restoration were most related to attitudes. To do so, we regressed attitudes toward supporting elk restoration onto the set of 14 beliefs about outcomes of supporting elk restoration for landowners (Table 1-17) and local residents (Table 1-18) separately.

Table 1-16. Regression of support for restoration of a wild, free-ranging within the study areas in Minnesota on attitudes and normative beliefs.

	B	SE	β	t	p	R^2
Landowners						0.63
(Constant)	2.429	.100		24.321	.000	
Attitude toward supporting elk restoration in study areas	.382	.022	.362	17.566	.000	
Normative beliefs about whether most others think respondent should support elk restoration in study areas	.498	.022	.474	22.960	.000	
Local Residents						0.52
(Constant)	2.822	.130		21.719	.000	
Attitude toward supporting elk restoration in study areas	.468	.027	.430	17.454	.000	
Normative beliefs about whether most others think respondent should support elk restoration in study areas	.396	.027	.356	14.433	.000	

[1]All results reflect weighted values correcting for stratification, gender, and age.

Results indicate that for landowners' beliefs that restoration of elk would lead to restoring a native species, increase economic opportunities through elk-related tourism, increasing youth involvement and interest in the outdoors, providing elk hunting opportunities, and elk viewing opportunities were all strong positive predictors of positive attitudes toward elk restoration (Table 1-17). Conversely, beliefs that restoration of elk would negatively impact other wildlife, increase costs to taxpayers, increase risk of disease transmission to livestock and wildlife, and lead to conflict between deer and elk were negatively related to holding positive attitudes toward elk restoration.

Table 1-17. Regression of attitudes on beliefs about outcomes of supporting restoration of a wild, free-ranging within the study areas in Minnesota—Landowners.

	B	SE	β	T	p	Zero-order
(Constant)	.311	.039		7.864	.000	
Restore a native wildlife species	.367	.024	.352	15.419	.000	.716
Increase economic opportunities through elk-related tourism	.088	.021	.094	4.112	.000	.630
Increase youth involvement and interest in outdoors	.116	.021	.119	5.621	.000	.629
Provide opportunities to hunt elk	.063	.019	.066	3.341	.001	.576
Provide opportunities to view elk	.079	.02	.069	3.879	.000	.532
Increase damage to agriculture and personal property	-.032	.018	-.032	-1.762	.078	-.393
Increase conflict among people due to elk	-.004	.018	-.004	-0.194	.846	-.395
Conflict between elk and moose	.011	.023	.01	0.465	.642	-.400
Shift management focus from other wildlife species such as deer and moose	-.049	.019	-.047	-2.64	.008	-.403
Increase damage to trees and forest vegetation	-.031	.021	-.031	-1.499	.134	-.438
Conflict between elk and deer	-.039	.025	-.037	-1.54	.124	-.453
Increase risk of disease transmission to livestock and wildlife	-.062	.022	-.057	-2.839	.005	-.472
Increase cost to taxpayers	-.025	.018	-.025	-1.397	.163	-.492
Negatively impact other wildlife populations	-.086	.024	-.081	-3.654	.000	-.501

[1]All results reflect weighted values correcting for stratification, gender, and age. $R^2 = 0.60$

For local residents there was a similar pattern of results except that provide opportunities to hunt elk and increasing youth involvement and interest in the outdoors were not as strongly related to positive attitudes (Table 1-18).

Table 1-18. Regression of attitudes on beliefs about outcomes of supporting restoration of a wild, free-ranging within the study areas in Minnesota—Local Residents.

	B	SE	β	t	p	Zero-order
(Constant)	.163	.051		3.216	.001	
Restore a native wildlife species	.453	.03	.41	15.34	.000	.659
Increase economic opportunities through elk-related tourism	.116	.028	.115	4.177	.000	.536
Provide opportunities to view elk	.139	.025	.126	5.635	.000	.471
Increase youth involvement and interest in outdoors	.005	.023	.005	0.231	.817	.447
Provide opportunities to hunt elk	.000	.023	0	0.017	.987	.411
Shift management focus from other wildlife species such as deer and moose	-.023	.022	-.023	-1.058	.290	-.263
Conflict between elk and moose	.063	.033	.063	1.904	.057	-.303
Conflict between elk and deer	-.035	.034	-.035	-1.037	.300	-.354
Increase conflict among people due to elk	-.001	.022	-.001	-0.032	.974	-.354
Increase damage to agriculture and personal property	-.046	.024	-.048	-1.925	.054	-.379
Increase cost to taxpayers	-.052	.022	-.055	-2.352	.019	-.382
Increase damage to trees and forest vegetation	-.097	.026	-.099	-3.659	.000	-.402
Increase risk of disease transmission to livestock and wildlife	-.116	.028	-.112	-4.127	.000	-.435
Negatively impact other wildlife populations	-.029	.03	-.028	-0.955	.340	-.436

[1]All results reflect weighted values correcting for stratification, gender, and age. $R^2 = 0.53$

Among both landowners and local residents, beliefs that most of their family and friends, most of their neighbors, most hunters they know, and most local residents and landowners level of support for elk restoration was strongly correlated to normative beliefs that most people they know think they should support elk restoration (Table 1-19 and Table 1-20).

Table 1-19. Regression of normative beliefs on beliefs about whether others think respondents should support restoration of a wild, free-ranging within the study areas in Minnesota—Landowners.

	B	SE	β	T	p	Zero-order
(Constant)	.833	.088		9.473	.000	
Most of my family and friends	.536	.022	.553	24.433	.000	.818
Most hunters I know	.215	.028	.212	7.565	.000	.743
Most of my neighbors	.041	.027	.039	1.532	.126	.688
Most local residents	.062	.027	.054	2.279	.023	.650
Most local landowners	.059	.024	.054	2.500	.012	.648
Most local hunting organizations	-.056	.025	-.051	-2.201	.028	.629
Local conservation/environmental organizations	.071	.019	.061	3.697	.000	.510
Local farmers & livestock producers	.020	.022	.018	.905	.365	.477
Local timber industry	-.032	.022	-.026	-1.467	.142	.464
Minnesota DNR	-.004	.019	-.003	-.206	.837	.446
Most local government officials	-.041	.020	-.032	-2.029	.043	.427
Local agricultural groups	.022	.023	.019	.969	.333	.405

[1]All results reflect weighted values correcting for stratification, gender, and age. $R^2 = 0.69$

Table 1-20. Regression of normative beliefs on beliefs about whether others think respondents should support restoration of a wild, free-ranging within the study areas in Minnesota—Local Residents.

	B	SE	β	T	p	Zero-order
(Constant)	1.326	.131		10.098	.000	
Most of my family and friends	.409	.026	.445	15.514	.000	.698
Most of my neighbors	.067	.035	.068	1.929	.054	.607
Most hunters I know	.161	.039	.167	4.180	.000	.585
Most local residents	.107	.035	.100	3.029	.002	.565
Most local hunting organizations	.018	.037	.019	.491	.623	.522
Most local landowners	.017	.030	.017	.559	.576	.481
Minnesota DNR	-.007	.026	-.006	-.256	.798	.364
Local conservation/environmental organizations	.027	.023	.028	1.174	.241	.350
Local timber industry	.029	.029	.026	.977	.329	.343
Local farmers & livestock producers	-.009	.031	-.009	-.299	.765	.330
Local agricultural groups	.064	.033	.061	1.973	.049	.319
Most local government officials	-.065	.027	-.057	-2.401	.016	.302

[1]All results reflect weighted values correcting for stratification, gender, and age. $R^2 = 0.54$

Importance of Management Decisions

Landowners and local residents were asked how important or unimportant decisions regarding the potential restoration of wild, free-ranging elk with the study areas in Minnesota were to the respondent personally (Table 1-21). A 7-point scale ranging from "very unimportant" (1) to "very important" (7) was used to measure the importance of the decisions concerning elk restoration. Management decisions regarding potentially restoring elk were important for landowners and local residents across all strata. Over 70% of landowners (75%) and local residents (74%) indicated that decisions regarding the potential restoration of wild, free-ranging elk were important to them. There was no significant difference in the importance of management decisions between strata for landowners and local residents.

Table 1-21. Importance of decisions regarding the potential restoration of wild, free-ranging elk within the study areas in Minnesota.

	n	Very Unimportant						Very Important	Mean[2]	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,507**	**4.3%**	**2.9%**	**2.1%**	**15.4%**	**18.7%**	**27.9%**	**28.7%**	**5.2**	
Cloquet Valley	826	4.6%	2.2%	2.4%	15.3%	19.1%	27.2%	29.2%	5.4	F = 2.91 n.s.
Fond du Lac	776	4.9%	3.3%	1.8%	16.2%	19.6%	28.3%	25.9%	5.3	
Nemadji	905	3.2%	3.3%	2.2%	14.5%	17.4%	28.0%	31.3%	5.5	
Local Residents	**1,560**	**2.9%**	**3.0%**	**2.9%**	**17.0%**	**28.0%**	**26.5%**	**19.8%**	**5.3**	
Carlton	368	2.7%	3.8%	3.0%	18.0%	28.9%	22.9%	20.7%	5.2	F = 2.70 n.s.
Duluth	356	2.8%	2.2%	3.7%	17.1%	30.3%	26.7%	17.1%	5.2	
Pine	391	2.3%	2.6%	1.8%	22.0%	21.5%	22.8%	27.1%	5.3	
St Louis	445	3.6%	4.0%	1.6%	11.0%	21.6%	34.4%	23.8%	5.4	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2] Mean based on scale: 1 = very unimportant, 2 = moderately unimportant, 3 = slightly unimportant, 4 = neither, 5 = slightly important, 6 = moderately important, 7 = very important
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Affective reactions toward Elk Restoration

Landowners and local residents were asked whether they feel worried, interested, and/or supportive when thinking about potentially restoring wild, free-ranging elk within the study areas in Minnesota. An 11-point scale from "none" (0) to "a lot" (10) was used to determine the occurrence of each feeling. On average, landowners ($\bar{x}$ = 2.2) and local residents ($\bar{x}$ = 2.2) indicated that they felt low levels of worry when thinking about potentially restoring elk (Table 1-22). About half of landowners (49%) and 4 out of 10 local residents (42%) indicated that they did not feel worried (none) about potentially restoring elk within the study areas. Landowners' feelings of worry varied significantly between strata (F = 7.17, p < .001) with Fond du Lac landowners expressing the highest level of worry ($\bar{x}$ = 2.6). Local residents' feelings of worry also varied significantly between strata (F = 7.07, p < .001) with Carlton ($\bar{x}$ = 2.7) and Pine County ($\bar{x}$ = 2.8) residents expressing the highest level of worry. However, less than 10% of landowners or local residents expressed more than moderate levels (>7) of worry.

Table 1-22. When thinking about potentially restoring wild, free-ranging elk within study areas in Minnesota, how much does the respondent feel worried?

	n	None					Moderate					A lot	Mean	ANOVA
		0	1	2	3	4	5	6	7	8	9	10		
Landowners	**2,404**	**48.7%**	**9.2%**	**8.9%**	**5.4%**	**3.6%**	**10.6%**	**2.6%**	**2.4%**	**2.7%**	**1.2%**	**4.8%**	**2.2**	
Cloquet Valley	793	52.7%	9.1%	7.6%	5.4%	2.6%	11.2%	1.9%	2.0%	2.4%	0.8%	4.3%	2.0	F = 7.17 *** η^2 = .006
Fond du Lac	748	44.6%	8.0%	9.8%	5.1%	5.1%	10.3%	3.6%	3.2%	3.1%	1.7%	5.5%	2.6	
Nemadji	862	49.0%	10.7%	9.3%	5.8%	3.1%	10.0%	2.2%	1.7%	2.6%	0.9%	4.8%	2.1	
Local Residents	**1,503**	**41.5%**	**12.6%**	**11.6%**	**8.2%**	**4.8%**	**10.0%**	**2.1%**	**2.8%**	**2.2%**	**0.6%**	**3.6%**	**2.2**	
Carlton	357	37.5%	11.5%	7.6%	9.6%	5.1%	13.0%	2.5%	3.7%	3.1%	1.1%	5.4%	2.7	F = 7.07*** η^2 = .014
Duluth	347	43.5%	13.8%	14.1%	7.5%	5.2%	7.8%	1.4%	1.7%	1.7%	0.0%	3.2%	1.9	
Pine	377	36.8%	11.6%	6.9%	5.8%	4.5%	16.9%	4.8%	4.2%	2.9%	1.9%	3.7%	2.8	
St Louis	423	41.0%	10.1%	9.9%	10.8%	2.8%	9.9%	3.3%	5.2%	1.9%	0.2%	4.7%	2.4	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

On average, landowners ($\bar{x}$ = 7.4) and local residents ($\bar{x}$ = 7.2) expressed moderate to high levels of interest when thinking about potentially restoring wild, free-ranging elk (Table 1-23). Over 30% of landowners (37.1%) and 30% of local residents (29.6%) indicated a lot of interest about potentially restoring elk within the study areas. Landowners' interest varied significantly between strata (F = 9.27, p < .001) with Nemadji landowners expressing the highest level of interest ($\bar{x}$ = 7.7). Local residents' interest also varied significantly between strata (F = 7.48, p < .001) with St. Louis County residents expressing the most interest ($\bar{x}$ = 7.8).

Table 1-23. When thinking about potentially restoring wild, free-ranging elk within study areas in Minnesota, how much does the respondent feel interested?

	n	None				Moderate						A lot	Mean	ANOVA
		0	1	2	3	4	5	6	7	8	9	10		
Landowners	**2,434**	**5.7%**	**1.3%**	**1.8%**	**1.9%**	**2.3%**	**13.2%**	**5.8%**	**7.8%**	**13.3%**	**9.6%**	**37.1%**	**7.4**	
Cloquet Valley	804	5.0%	1.2%	2.1%	1.4%	2.4%	13.3%	5.6%	7.1%	12.7%	11.3%	37.9%	7.5	F = 9.27 ***
Fond du Lac	756	7.3%	1.7%	1.3%	2.9%	2.4%	14.0%	6.5%	8.9%	14.6%	7.9%	32.5%	7.1	η^2 = .008
Nemadji	874	4.7%	0.8%	2.1%	1.4%	2.1%	12.3%	5.3%	7.6%	12.5%	9.7%	41.7%	7.7	
Local Residents	**1,514**	**4.7%**	**2.0%**	**3.2%**	**1.8%**	**2.7%**	**12.2%**	**7.7%**	**11.0%**	**14.0%**	**11.1%**	**29.6%**	**7.2**	
Carlton	354	5.1%	1.4%	1.7%	1.7%	3.7%	15.9%	9.6%	10.2%	13.3%	10.2%	27.2%	7.0	F = 7.48 ***
Duluth	350	4.9%	2.9%	4.3%	1.7%	3.4%	10.9%	7.2%	11.5%	13.5%	11.5%	28.4%	7.0	η^2 = .012
Pine	382	3.7%	0.8%	1.3%	2.4%	1.0%	14.7%	6.3%	9.2%	17.0%	9.7%	34.0%	7.5	
St Louis	428	4.0%	0.9%	0.7%	1.2%	1.2%	8.6%	8.8%	12.6%	13.5%	12.3%	36.3%	7.8	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

On average, landowners ($\bar{x}$ = 7.3) and local residents ($\bar{x}$ = 7.3) expressed moderate to high levels of support when thinking about potentially restoring wild, free-ranging elk (Table 1-24). Over 30% of landowners (38%) and local residents (32%) indicated a lot of support for potentially restoring elk with the study areas. Landowners' support varied significantly between strata (F = 7.48, $p < .001$) with Fond du Lac landowners' expressing the least support ($\bar{x}$ = 6.9) and Nemadji landowners the most support ($\bar{x}$ = 7.5). Local residents' support also varied significantly between strata (F = 2.89, $p < .05$) with St. Louis County residents expressing the most support ($\bar{x}$ = 7.5) and Carlton County residents the least support ($\bar{x}$ = 7.5).

Table 1-24. When thinking about potentially restoring wild, free-ranging elk within study areas in Minnesota, how much does the respondent feel supportive?

	N	None				Moderate						A lot	Mean	ANOVA
		0	1	2	3	4	5	6	7	8	9	10		
Landowners	**2,477**	**7.4%**	**2.0%**	**2.0%**	**2.2%**	**2.8%**	**11.7%**	**4.8%**	**6.6%**	**12.1%**	**10.3%**	**38.2%**	**7.3**	
Cloquet Valley	822	6.8%	1.7%	2.2%	1.5%	2.3%	12.3%	4.1%	6.7%	11.5%	11.5%	39.4%	7.4	F = 7.48 ***
Fond du Lac	762	8.3%	2.9%	2.2%	3.1%	3.3%	11.5%	6.4%	7.6%	11.4%	8.4%	34.9%	6.9	η^2 = .006
Nemadji	893	6.9%	1.3%	1.5%	2.0%	2.8%	11.2%	3.8%	5.4%	13.4%	11.2%	40.5%	7.5	
Local Residents	**1,524**	**5.4%**	**2.0%**	**2.6%**	**2.4%**	**1.7%**	**11.1%**	**7.4%**	**10.1%**	**14.4%**	**10.7%**	**32.3%**	**7.3**	
Carlton	358	7.8%	3.1%	2.8%	1.7%	2.0%	12.9%	5.3%	11.8%	12.3%	9.8%	30.5%	6.9	
Duluth	349	4.3%	2.0%	2.9%	2.9%	1.7%	10.0%	8.6%	10.0%	14.3%	11.1%	32.3%	7.3	F = 2.89*
Pine	385	6.0%	2.1%	1.8%	2.3%	1.3%	14.5%	4.2%	6.0%	20.5%	7.8%	33.5%	7.3	η^2 = .009
St Louis	432	5.6%	1.4%	1.2%	1.6%	1.9%	9.5%	8.6%	10.0%	12.7%	12.0%	35.6%	7.5	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Hunter/Non-Hunter

We examined whether hunters and non-hunters differed in their support for restoring wild, free-ranging elk to the study areas in Minnesota. Respondents were determined to be hunters if they had participated in deer hunting and/or other hunting or trapping activities in the last 12 months. Hunters were significantly more supportive of restoring elk to the study areas in Minnesota than non-hunters among both landowners ($F = 11.97$, $p < .001$) and local residents ($F = 7.95$, $p < .01$) (Table 1-25). A slightly larger proportion of landowners (82% vs 75%) and local residents (80% vs 75%) who hunted were more supportive of restoring an elk population to the study areas than non-hunting respondents. Support for restoring elk to the study areas was not significantly different between strata for landowners ($F = 2.27$, $p = .10$; Cloquet Valley: 83%, Fond du Lac: 79%, Nemadji: 82%) or local residents ($F = 2.37$, $p = .07$; Carlton: 75%, Duluth: 86%, Pine: 78%, St. Louis: 83%) that hunted and local residents that do not hunt ($F = 1.93$, $p = .12$; Carlton: 70%, Duluth: 76%, Pine: 73%, St. Louis: 79%), although support was significantly different between strata for non-hunting landowners ($F = 7.61$, $p < .001$) with Fond du Lac landowners least likely to support restoring elk to the study areas (Cloquet Valley: 78%, Fond du Lac: 67%, Nemadji: 79%).

Table 1-25. Hunter/non-hunter support for restoring wild, free-ranging elk to the study areas in Minnesota.

	n	Strongly Oppose						Strongly Support	Mean[1]	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,472**	**6.7%**	**3.0%**	**2.5%**	**8.5%**	**11.9%**	**24.4%**	**43.0%**	**5.6**	F = 11.97 *** η^2 = .005
Hunter	1,679	6.5%	3.1%	2.4%	6.5%	10.8%	25.0%	45.7%	5.7	
Non-hunter	793	7.1%	2.6%	2.8%	12.7%	14.2%	23.1%	37.5%	5.4	
Local Residents	**1,558**	**2.9%**	**3.0%**	**2.9%**	**17.0%**	**28.0%**	**26.5%**	**19.8%**	**5.3**	F = 7.95 ** η^2 = .005
Hunter	665	7.4%	3.0%	1.7%	8.1%	9.9%	26.0%	43.9%	5.6	
Non-hunter	853	6.3%	3.2%	2.6%	13.1%	16.5%	25.1%	33.2%	5.4	

[1] Mean based on scale: 1 = strongly oppose, 2 = moderately oppose, 3 = slightly oppose, 4 = neutral, 5 = slightly support, 6 = moderately support, 7 = strongly support

F compares strata within study area.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Farmer/Non-Farmer

We examined whether farmers and non-farmers differed in their support for restoring wild, free-ranging elk to the study areas in Minnesota. Respondents were determined to be farmers if they indicated that a portion of their household income was derived from agricultural activities. Analysis was limited to landowners since questions related to agriculture activities were excluded from the local resident questionnaire. Non-farmers were significantly more supportive of restoring elk to the study areas in Minnesota than farmers (Table 1-26). Non-farmers were significantly more supportive than farmers ($F = 27.86$, $p < .001$) with 73% of farmers and 82% of non-farmers supporting the restoration of an elk population to the study areas. Support for restoring elk to the study areas was not significantly different between strata for farmers ($F = 1.46$, $p = .23$; Cloquet Valley: 79%, Fond du Lac: 70%, Nemadji: 71%), though support was significantly different between strata for non-farmers ($F = 9.52$, $p < .001$) with Fond du Lac landowners least likely to support restoring elk to the study areas (Cloquet Valley: 84%, Fond du Lac: 77%, Nemadji: 85%).

Table 1-26. Support for restoring wild, free-ranging elk to the study areas in Minnesota based on farming income.

	N	Strongly Oppose 1	2	3	4	5	6	Strongly Support 7	Mean[1]	ANOVA
Landowners	**2,472**	**6.7%**	**3.0%**	**2.5%**	**8.5%**	**11.9%**	**24.4%**	**43.0%**	**5.6**	F = 27.86 *** η^2 = .012
Farmers	406	11.1%	5.9%	2.5%	7.9%	10.8%	22.7%	39.2%	5.3	
Non-farmers	1,924	4.9%	2.3%	2.5%	8.2%	12.0%	25.4%	44.8%	5.8	

[1] Mean based on scale: 1 = strongly oppose, 2 = moderately oppose, 3 = slightly oppose, 4 = neutral, 5 = slightly support, 6 = moderately support, 7 = strongly support

F compares strata within study area.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Timber producer/Non-Producer

We examined whether timber producers and non-producers differed in their support for restoring wild, free-ranging elk to the study areas in Minnesota. Respondents were determined to be timber producers if they indicated that they used a portion of their land for timber production during the last 5 years. Analysis was limited to landowners since questions related to land use activities were excluded from the local resident questionnaire. Non-producers were significantly more supportive of restoring wild, free-ranging elk to the study areas in Minnesota than timber producers ($F = 16.97$, $p < .001$) with 81% of non-producers and 76% of timber producers supporting the restoration of an elk population to the study areas (Table 1-27). Support for restoring elk to the study areas was not significantly different between strata for timber producers ($F = 2.14$, $p = .12$; Cloquet Valley: 81.8%, Fond du Lac: 73.0%, Nemadji: 72.2%), though support was significantly different between strata for non-producers ($F = 10.69$, $p < .001$) with Fond du Lac landowners least likely to support restoring elk to the study areas (Cloquet Valley: 81.4%, Fond du Lac: 74.9%, Nemadji: 84.7%).

Table 1-27. Timber producers/non-producers support for restoring wild, free-ranging elk to study areas in Minnesota.

	n	Strongly Oppose						Strongly Support	Mean[1]	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,472**	**6.7%**	**3.0%**	**2.5%**	**8.5%**	**11.9%**	**24.4%**	**43.0%**	**5.6**	F = 16.97 *** η^2 = .007
Producers	597	10.6%	4.5%	3.0%	6.4%	11.1%	25.3%	39.2%	5.4	
Non-producers	1,875	5.4%	2.5%	2.4%	9.2%	12.2%	24.1%	44.3%	5.7	

[1] Mean based on scale: 1 = strongly oppose, 2 = moderately oppose, 3 = slightly oppose, 4 = neutral, 5 = slightly support, 6 = moderately support, 7 = strongly support

F compares strata within study area.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Section 2. Importance of Issues Related to Elk Restoration

Measuring landowners and local residents preferences for management objectives allows managers to understand stakeholder desires for potentially restoring elk to study areas in Minnesota and improve implementation of tools, such as education (Cohen, 2003). We used a Best-Worst Scaling (BWS), or Maximum Difference (MaxDiff), approach to determine preferences regarding the most important and least important objectives to stakeholders. Respondents were presented with eight scenarios that included 5 objectives to consider related to elk restoration. Objectives for each scenario were randomly selected from a list of ten objectives based on suggestions from local stakeholders during focus groups and local natural resources professionals. Best-Worst Scaling tasks were created using Sawtooth software and the program was used to analyze results (Version 9.5.3, www.sawtoothsoftware.com, accessed 23 June 2018). Respondents were asked to identify the objective that they consider most important and least important within each objective set. Respondents were randomly assigned one of three versions of the survey that had different sets of random objectives, which allowed for more precise estimates and reduce context and order effects (Sawtooth Software Inc, 2013). Our analysis assigns a weight to each objective and rank to identify the objectives considered most/least important by stakeholders. Weights indicate the importance of each objective to the respondent with larger weights indicating the objective was more important to respondents. Weights were on a 0 to 100 scale with the total weight of all objectives equaling 100 and allowing comparison between objectives (i.e., an objective with a weight of 10 would be twice as important to a respondent as an objective with a weight of 5).

Based on the results of the BWS analysis, landowners and local residents ranked management objectives similarly (Table 2-1). The most important management objectives for landowners were: (1) minimizing impacts to existing wildlife populations (e.g., disease, resource competition), (2) restoration of a native species, and (3) minimizing impacts to deer populations and deer hunting. The least important management objectives for landowners were: (8) minimizing costs of government elk management actions, (9) providing elk viewing opportunities, and (10) maximizing economic opportunities through elk-related tourism and recreation. The most important management objectives for local residents were: (1) minimizing impacts to existing wildlife populations (e.g., disease, resource competition), (2) restoration of a native species, and (3) maximizing sustainable elk population size. The least important management objectives for local residents were: (8) providing elk hunting opportunities, (9) maximizing economic opportunities through elk-related tourism and recreation, and (10) providing elk viewing opportunities.

Table 2-1. Landowner and Local Resident Perception of Management Objective Importance Related to Restoring a Wild, Free-Ranging Elk Population to the Study Areas in Minnesota.

Objective	Landowners		Local Residents	
	Rank	Weight (95% CI)	Rank	Weight (95% CI)
Minimize costs of government elk management actions	8	7.4 (7.1, 7.7)	6	8.5 (8.0, 8.9)
Minimize damage to agriculture and personal property (e.g., fences, vehicles)	4	11.9 (11.5, 12.3)	4	11.5 (11.0, 12.0)
Minimize damage to trees and forest vegetation	7	7.7 (7.4, 8.0)	7	7.2 (6.9, 7.6)
Provide elk hunting opportunities	6	9.4 (8.9, 9.8)	8	6.5 (6.1, 7.0)
Provide elk viewing opportunities	9	3.6 (3.3, 3.9)	10	4.8 (4.4, 5.2)
Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	1	17.4 (17.1, 17.7)	1	17.5 (17.1, 18.0)
Maximum sustainable elk population size	5	11.6 (11.2, 12.0)	3	12.2 (11.7, 12.8)
Maximize economic opportunities through elk-related tourism and recreation	10	3.3 (3.1, 3.6)	9	5.3 (5.0, 5.7)
Restoration of a native species	2	14.0 (13.6, 14.5)	2	16.8 (16.2, 17.4)
Minimize impacts to deer populations and deer hunting	3	13.6 (13.3, 14.0)	5	9.6 (9.1, 10.0)

Section 3. Benefits and Risks of Restoring Elk

Risks

We were interested in understanding landowners' and local residents' perceptions of the potential risks and benefits from restoring wild, free-ranging elk within the study areas in Minnesota. Landowners and local residents were asked the severity of potential risks from restoring elk within the study areas (Table 3-1). A 7-point scale from "no risk" (1) to "extreme risk" (7) was used to determine perceptions of potential risks from restoring elk. On average, landowners ($\bar{x}$ = 3.7) and local residents ($\bar{x}$ = 3.6) perceived that there would potentially be moderate risk from restoring elk within the study areas. Perceptions of potential risks from restoring elk to the study areas varied significantly between strata for landowners (F = 10.22, $p < .001$) and local residents (F = 6.27, $p < .001$).

Table 3-1. Potential risks from restoring wild, free-ranging elk within the study areas in Minnesota.

	n	No Risk		Moderate Risk			Extreme Risk		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,388**	**9.6%**	**17.7%**	**17.0%**	**26.4%**	**16.2%**	**7.9%**	**5.1%**	**3.7**	
Cloquet Valley	785	11.2%	21.2%	17.4%	24.4%	15.0%	7.4%	3.6%	3.5	F = 10.22 ***
Fond du Lac	747	7.1%	15.5%	16.2%	28.8%	17.9%	8.4%	6.0%	3.9	η^2 = .009
Nemadji	856	11.0%	16.3%	17.5%	26.1%	15.4%	7.9%	5.7%	3.7	
Local Residents	**1,497**	**8.9%**	**16.1%**	**21.5%**	**28.8%**	**15.3%**	**6.6%**	**2.8%**	**3.6**	
Carlton	351	8.8%	10.3%	20.2%	30.2%	18.8%	6.6%	5.1%	3.8	
Duluth	338	9.7%	17.1%	22.7%	28.9%	13.6%	6.5%	1.5%	3.4	F = 6.27 ***
Pine	378	6.1%	15.3%	15.6%	27.8%	23.5%	7.9%	3.7%	3.9	η^2 = .011
St Louis	430	6.5%	20.2%	20.4%	29.7%	15.1%	3.2%	4.9%	3.6	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Landowners and local residents were asked how much threat having elk within the study areas would pose to: (1) respondents' own economic well-being (agriculture, personal property); (2) respondents' own health/safety (vehicle collisions, etc.); (3) the economic well-being of individuals in the local community (agriculture, personal property); (4) the health/safety of individuals in the local community (vehicle collisions, etc.); (5) other wildlife in area (disease, etc.); and (6) trees and forest vegetation. A 7-point scale from "no threat" (1) to "extreme threat" (7) was used to determine perceptions of threats from having elk within the study areas. On average, landowners ($\bar{x}$ = 2.2) and local residents ($\bar{x}$ = 2.2) perceived that having elk within the study areas would pose little threat to the respondents' own economic well-being (agriculture, personal property) (Table 3-2). Perceived threat from having elk within the study areas to the respondents' own economic well-being (agriculture, personal property) varied significantly between strata for landowners (F = 6.62, $p < .001$), and between strata for local residents (F = 4.49, $p <$ .01). On average, landowners ($\bar{x}$ = 2.8) and local residents ($\bar{x}$ = 3.0) perceived that having elk within the study area would pose little to moderate threat to the respondents' own health/safety (vehicle collisions, etc.) (Table 3-3). Perceived threat from having elk within the study areas to the respondents' own health/safety (vehicle collisions, etc.) varied significantly between strata for landowners (F = 7.67, $p <$ .001) and local residents (F = 7.97, $p < .001$).

Table 3-2. If elk were restored within the study areas, perceived threat from elk posed to… Own economic well-being (agriculture, personal property)?

	n	No Threat			Moderate Threat			Extreme Threat	Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,400**	**46.6%**	**21.5%**	**11.1%**	**12.3%**	**3.2%**	**2.5%**	**2.8%**	**2.2**	
Cloquet Valley	791	48.9%	20.8%	12.4%	11.1%	2.8%	2.1%	1.9%	2.1	F = 6.62 *** η^2 = .006
Fond du Lac	754	40.5%	23.4%	11.8%	15.0%	3.1%	2.8%	3.5%	2.4	
Nemadji	855	51.2%	20.0%	8.7%	10.4%	3.9%	2.7%	3.2%	2.2	
Local Residents	**1,510**	**43.8%**	**24.7%**	**13.7%**	**9.9%**	**4.0%**	**1.7%**	**2.0%**	**2.2**	
Carlton	357	42.4%	20.2%	11.8%	13.2%	7.3%	1.4%	3.7%	2.3	F = 4.49 ** η^2 = .005
Duluth	343	46.4%	26.4%	13.9%	7.0%	3.2%	2.0%	1.2%	2.1	
Pine	370	40.8%	22.9%	14.4%	13.9%	3.2%	2.1%	2.7%	2.3	
St Louis	425	37.3%	25.6%	14.2%	14.7%	3.3%	1.6%	3.3%	2.2	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 3-3. If elk were restored within the study areas, perceived threat from elk posed to… Own health/safety (vehicle collisions, etc.)?

	n	No Threat		Moderate Threat			Extreme Threat		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,403**	**24.5%**	**28.5%**	**16.1%**	**17.5%**	**5.5%**	**4.0%**	**4.0%**	**2.8**	
Cloquet Valley	793	24.2%	29.1%	16.6%	18.5%	4.2%	3.8%	3.8%	2.8	F = 7.67 ***
Fond du Lac	756	21.6%	26.3%	17.2%	18.4%	7.8%	4.2%	4.5%	3.0	η^2 = .007
Nemadji	854	28.3%	30.3%	14.0%	15.3%	4.3%	3.9%	3.9%	2.6	
Local Residents	**1,509**	**15.5%**	**30.8%**	**16.5%**	**21.8%**	**8.4%**	**3.6%**	**3.3%**	**3.0**	
Carlton	358	14.0%	24.9%	15.4%	24.0%	10.1%	4.7%	7.0%	3.2	
Duluth	341	16.9%	34.3%	17.2%	21.5%	5.8%	2.6%	1.7%	2.8	F = 7.97 ***
Pine	370	13.9%	24.8%	16.3%	22.9%	12.3%	6.4%	3.5%	3.1	η^2 = .011
St Louis	427	16.0%	28.5%	13.9%	20.0%	13.9%	4.6%	3.0%	3.0	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

On average, landowners ($\bar{x}$ = 2.7) and local residents ($\bar{x}$ = 2.8) perceived that having elk within the study area would pose little to moderate threat to the economic well-being of individuals in the local community (agriculture, personal property) (Table 3-4). Perceived threat from having elk within the study areas to the economic well-being of other individuals in the local community (agriculture, personal property) varied significantly between strata for landowners (F = 10.65, $p < .001$) and local residents (F = 6.49, $p < .001$). On average, landowners ($\bar{x}$ = 3.0) and local residents ($\bar{x}$ = 3.2) perceived that having elk within the study areas would pose moderate threat to the health/safety of other individuals in the local community (vehicle collisions, etc.) (Table 3-5). Perceived threat from having elk within the study areas to the health/safety of individuals in the local community (vehicle collisions, etc.) varied significantly between strata for landowners (F = 6.21, $p < .01$), and local residents (F = 5.47, $p = .001$). Overall, landowners and local residents perceived that elk would pose the greatest threat to the health/safety of other individuals in the local community (vehicle collisions, etc.) and the least threat to the respondents' own economic well-being (agriculture, personal property).

Table 3-4. If elk were restored within the study areas, perceived threat from elk posed to… The economic well-being of individuals in the local community (agriculture, personal property)?

	n	No Threat		Moderate Threat			Extreme Threat		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,385**	**22.9%**	**31.6%**	**17.6%**	**16.7%**	**5.3%**	**3.1%**	**2.7%**	**2.7**	
Cloquet Valley	785	26.3%	33.5%	16.8%	14.8%	5.1%	1.9%	1.6%	2.5	F = 10.65 ***
Fond du Lac	749	20.6%	29.3%	17.9%	20.1%	4.8%	4.0%	3.3%	2.9	η^2 = .009
Nemadji	851	21.9%	32.1%	18.2%	15.1%	6.1%	3.3%	3.3%	2.7	
Local Residents	**1,488**	**19.3%**	**29.6%**	**19.8%**	**20.1%**	**7.3%**	**1.8%**	**2.0%**	**2.8**	
Carlton	352	18.2%	23.1%	21.7%	21.1%	10.5%	1.4%	4.0%	3.0	
Duluth	337	21.6%	31.7%	18.0%	19.8%	5.9%	1.8%	1.2%	2.7	F = 6.49 ***
Pine	369	14.7%	27.8%	19.8%	20.1%	11.2%	3.7%	2.7%	3.0	η^2 = .009
St Louis	423	17.1%	29.7%	24.3%	18.9%	5.8%	2.6%	1.6%	2.7	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 3-5. If elk were restored within the study areas, perceived threat from elk posed to… The health/safety of individuals in the local community (vehicle collisions, etc.)?

	n	No Threat		Moderate Threat			Extreme Threat		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,383**	**16.4%**	**29.7%**	**18.5%**	**19.8%**	**7.5%**	**4.3%**	**3.9%**	**3.0**	
Cloquet Valley	784	17.6%	29.8%	19.5%	18.8%	7.0%	3.6%	3.7%	2.9	F = 6.21 **
Fond du Lac	751	13.6%	27.9%	19.2%	20.9%	9.1%	5.3%	4.0%	3.2	η^2 = .005
Nemadji	848	18.3%	31.7%	16.6%	19.6%	6.2%	3.8%	3.9%	2.9	
Local Residents	**1,493**	**11.7%**	**26.6%**	**19.4%**	**24.4%**	**9.7%**	**4.5%**	**3.7%**	**3.2**	
Carlton	350	13.4%	23.1%	16.9%	25.7%	7.7%	5.7%	7.4%	3.3	
Duluth	340	12.4%	28.2%	20.0%	25.0%	9.1%	2.9%	2.4%	3.1	F = 5.47 ***
Pine	370	8.6%	22.7%	20.1%	20.6%	15.0%	9.4%	3.7%	3.4	η^2 = .005
St Louis	425	11.5%	26.9%	19.2%	22.2%	11.9%	5.2%	3.0%	3.2	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

On average, landowners ($\bar{x}$ = 3.0) and local residents ($\bar{x}$ = 3.2) perceived that having elk within the study area would pose moderate threat to other wildlife in the area (disease, etc.) (Table 3-6). Perceived threat from having elk within the study areas to other wildlife in the area (disease, etc.) varied significantly between strata for landowners (F = 5.55, $p < .01$), though perceived threat was not significantly different between strata for local residents (F = .41, $p = .88$). On average, landowners ($\bar{x}$ = 3.0) and local residents ($\bar{x}$ = 3.1) perceived that having elk within the study area would pose moderate threat to trees and forest vegetation (Table 3-7). Perceived threat from having elk within the study areas to trees and forest vegetation varied significantly between strata for landowners (F = 3.89, $p < .05$), but perceived threat was not significantly different between strata for local residents (F = .11, *n.s.*). Overall, landowners and local residents perceived that elk would pose the greatest threat to the health/safety of other individuals in the local community (vehicle collisions, etc.) and the least threat to the respondents' own economic well-being (agriculture, personal property).

Table 3-6. If elk were restored within the study areas, perceived threat from elk posed to… Other wildlife in area (disease, etc.)?

	N	No Threat		Moderate Threat			Extreme Threat		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,385**	**16.2%**	**27.3%**	**20.5%**	**20.7%**	**7.6%**	**3.8%**	**4.1%**	**3.0**	
Cloquet Valley	787	16.6%	28.4%	22.8%	19.3%	6.6%	2.9%	3.3%	2.9	F = 5.55 **
Fond du Lac	750	14.4%	25.0%	20.4%	22.4%	8.4%	4.8%	4.5%	3.2	η^2 = .005
Nemadji	848	17.6%	28.7%	17.8%	20.3%	7.7%	3.5%	4.4%	3.0	
Local Residents	**1,486**	**11.9%**	**27.5%**	**19.0%**	**25.3%**	**9.1%**	**5.1%**	**2.2%**	**3.2**	
Carlton	349	14.2%	23.4%	18.8%	23.4%	12.4%	3.8%	4.0%	3.2	
Duluth	338	11.2%	28.8%	19.1%	25.6%	8.2%	5.9%	1.2%	3.1	F = .41 n.s.
Pine	369	16.3%	25.7%	16.0%	21.4%	10.2%	7.2%	3.2%	3.1	
St Louis	425	9.3%	28.0%	24.1%	25.5%	7.2%	3.3%	2.6%	3.1	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 3-7. If elk were restored within the study areas, perceived threat from elk posed to… Trees and forest vegetation?

	N	No Threat		Moderate Threat			Extreme Threat		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,397**	**20.2%**	**25.8%**	**19.1%**	**18.9%**	**8.6%**	**4.0%**	**3.5%**	**3.0**	
Cloquet Valley	789	20.1%	26.9%	21.1%	18.3%	7.8%	3.4%	2.4%	2.9	$F = 3.89$ * $\eta^2 = .004$
Fond du Lac	755	18.0%	25.3%	18.1%	20.8%	8.6%	5.3%	4.0%	3.1	
Nemadji	853	22.7%	25.0%	17.9%	17.4%	9.4%	3.4%	4.2%	2.9	
Local Residents	**1,497**	**16.0%**	**23.0%**	**18.9%**	**25.6%**	**9.3%**	**4.4%**	**2.8%**	**3.1**	
Carlton	352	18.9%	22.6%	17.5%	22.3%	11.7%	3.4%	3.4%	3.1	$F = .11$ n.s.
Duluth	341	15.2%	22.4%	19.8%	27.1%	9.3%	3.8%	2.3%	3.1	
Pine	371	16.0%	24.9%	19.3%	20.6%	8.0%	8.6%	2.7%	3.1	
St Louis	425	15.9%	25.2%	17.2%	25.6%	7.0%	5.4%	3.7%	3.0	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Benefits

Landowners and local residents were asked how great are the potential benefits of restoring wild, free-ranging elk within the study areas in Minnesota (Table 3-8). A 7-point scale from "no benefit" (1) to "extreme benefit" (7) was used to determine perceptions of potential benefits from restoring elk within the study areas. On average, landowners ($\bar{x}$ = 4.8) and local residents ($\bar{x}$ = 5.1) perceived that there would potentially be moderate to high potential benefits from restoring elk within the study areas. Perceptions of potential benefits from restoring elk within the study areas varied significantly between strata for landowners (F = 7.70, $p < .001$) and local residents (F = 9.12, $p < .001$).

Table 3-8. Potential benefits of restoring wild, free-ranging elk within the study areas in Minnesota.

	n	No Benefit			Moderate Benefit			Extreme Benefit	Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,415**	**7.1%**	**5.9%**	**5.9%**	**16.1%**	**22.2%**	**26.0%**	**16.8%**	**4.8**	
Cloquet Valley	796	6.4%	4.5%	5.0%	16.4%	21.8%	26.9%	18.9%	4.9	F = 7.70 ***
Fond du Lac	754	8.5%	7.2%	6.5%	16.8%	22.5%	25.7%	12.8%	4.7	η^2 = .008
Nemadji	865	6.5%	5.9%	6.2%	14.8%	22.4%	25.1%	19.1%	4.9	
Local Residents	**1,512**	**4.1%**	**2.8%**	**5.9%**	**15.3%**	**25.5%**	**32.3%**	**14.0%**	**5.1**	
Carlton	357	7.6%	5.9%	7.3%	15.4%	29.5%	23.6%	10.7%	4.7	
Duluth	344	2.9%	1.4%	6.1%	15.1%	24.6%	35.7%	14.2%	5.2	F = 9.12 ***
Pine	379	3.9%	4.7%	5.0%	16.6%	25.0%	29.2%	15.5%	5.0	η^2 = .011
St Louis	432	4.9%	2.5%	3.5%	15.7%	24.8%	32.9%	15.7%	5.1	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Certainty

Landowners and local residents were asked how certain they were about potential risks and benefits from restoring wild, free-ranging elk within the study areas in Minnesota (Table 3-9). A 7-point scale from "very uncertain" (1) to "very certain" (7) was used to determine respondents' certainty with the potential risks and benefits of restoring elk within the study areas. On average, landowners ($\bar{x}$ = 4.3) and local residents ($\bar{x}$ = 4.0) were neither certain nor uncertain about the potential risks and benefits of restoring elk within the study areas. Level of certainty about the potential risks and benefits from restoring elk within the study areas varied significantly, but not substantively among the strata for landowners (F = 3.82, p < .01) and local residents (F = 5.29, p < .001).

Table 3-9. Certainty about potential risks and benefits of restoring wild, free-ranging elk within the study areas in Minnesota.

	n	Very Uncertain						Very Certain	Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,413**	**6.7%**	**8.8%**	**11.5%**	**28.9%**	**19.1%**	**13.9%**	**11.1%**	**4.3**	
Cloquet Valley	794	7.4%	9.8%	11.4%	31.2%	18.1%	12.9%	9.2%	4.2	F = 3.82 ** η^2 = .004
Fond du Lac	755	5.8%	7.9%	11.9%	26.6%	21.0%	15.7%	11.1%	4.4	
Nemadji	864	6.7%	8.9%	11.1%	28.9%	18.1%	12.8%	13.4%	4.3	
Local Residents	**1,520**	**9.6%**	**10.5%**	**11.1%**	**31.9%**	**18.1%**	**12.7%**	**6.0%**	**4.0**	
Carlton	358	10.9%	10.1%	13.4%	31.6%	15.9%	10.9%	7.3%	3.9	
Duluth	344	9.9%	11.7%	9.6%	31.8%	18.4%	13.7%	5.0%	4.0	F = 5.29 *** η^2 = .012
Pine	375	6.1%	6.1%	11.5%	32.5%	19.7%	14.1%	9.9%	4.4	
St Louis	433	7.9%	8.5%	14.5%	32.8%	18.5%	11.1%	6.7%	4.1	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Personal Control

Landowners and local residents were asked how much personal control the respondent believes they would have to limit risk to themselves if wild, free-ranging elk are restored within the study areas in Minnesota (Table 3-10). A 7-point scale from "no control" (1) to "complete control" (7) was used to determine respondents' perceived personal control to limit risk if elk are restored within the study areas in Minnesota. On average, landowners ($\bar{x}$ = 3.5) and local residents ($\bar{x}$ = 3.9) were perceived that they would have moderate personal control to limit risk to themselves if elk are restored within the study areas in Minnesota. There was no significant difference in perceived personal control to limit risk to the respondent between strata for landowners (F = .01, *n.s.*) and small differences among local residents (F = 3.36, p = .05).

Table 3-10. Perceived personal control to limit risk to respondent if wild, free-ranging elk are restored within the study areas in Minnesota.

	n	No Control			Moderate Control			Complete Control	Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,417**	**22.4%**	**14.1%**	**11.4%**	**19.2%**	**11.9%**	**11.5%**	**9.5%**	**3.5**	
Cloquet Valley	799	23.5%	14.0%	9.4%	20.8%	10.6%	11.7%	10.0%	3.5	F = .01 n.s.
Fond du Lac	756	21.5%	13.5%	13.9%	17.7%	14.0%	9.9%	9.5%	3.5	
Nemadji	862	22.2%	14.8%	10.8%	19.1%	11.0%	13.1%	8.9%	3.6	
Local Residents	**1,521**	**16.9%**	**12.1%**	**10.9%**	**19.7%**	**16.1%**	**14.4%**	**9.8%**	**3.9**	
Carlton	357	23.8%	13.7%	11.2%	16.5%	13.7%	10.1%	10.9%	3.6	
Duluth	343	14.3%	11.7%	10.8%	19.0%	18.1%	16.1%	9.9%	4.0	F = 3.36 * η^2 = .005
Pine	375	18.4%	9.1%	13.9%	22.7%	12.5%	15.2%	8.3%	3.8	
St Louis	436	16.7%	14.2%	11.4%	22.9%	14.2%	11.9%	8.7%	3.7	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Landowners were asked how much personal control the respondent believed they would have to: (1) limit elk damage to their agricultural and personal property; (2) limit elk damage to their trees and forest vegetation; (3) limit impact of elk to deer and other wildlife in the study areas; and (4) influence elk management decisions in the study areas. A 7-point scale from "no control" (1) to "complete control" (7) was used to determine respondents' perceived personal control to limit risk if elk are restored within the study areas in Minnesota. Local residents were asked how much personal control the respondents believed they would have to influence elk management decisions in the study areas. On average, landowners perceived that they would have little control to limit elk damage to their own agricultural and personal property ($\bar{x}$ = 2.6) (Table 3-11). Perceived personal control to limit elk damage to respondents' agricultural and personal property was not significantly different between strata for landowners (F = 1.99, *n.s.*). On average, landowners perceived they would have little control to limit elk damage to respondents' trees and forest vegetation ($\bar{x}$ = 2.4) (Table 3-12). Perceived personal control to limit elk damage to

respondents' trees and forest vegetation was significantly different between strata for landowners (F = 3.21, p = .05), but mean differences were quite small. On average, landowners perceived they would have little control to limit impact to deer and other wildlife in the study areas ($\bar{x}$ = 2.1) (Table 3-13). Perceived personal control to limit impact of elk to deer and other wildlife in the study areas was not significantly different between strata for landowners (F = .19, *n.s.*). On average, landowners ($\bar{x}$ = 2.5) and local residents ($\bar{x}$ = 2.4) perceived they would have little control to influence elk management decisions in the study areas (Table 3-14). Perceived personal control to influence elk management decisions in the study areas was not significantly different between strata for landowners (F = 1.42, *n.s.*) and local residents (F = .66, *n.s.*).

Table 3-11. If wild, free-ranging elk are restored within the study areas in Minnesota, how much perceived control does respondent have to… Limit elk damage to own agricultural and personal property?

	n	No Control		Moderate Control			Complete Control		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,407**	**37.3%**	**21.0%**	**9.0%**	**19.1%**	**5.5%**	**4.6%**	**3.5%**	**2.6**	
Cloquet Valley	792	37.1%	21.6%	8.7%	20.4%	4.3%	4.3%	3.6%	2.6	F = 1.99 n.s.
Fond du Lac	757	34.4%	21.4%	10.2%	18.9%	6.7%	4.9%	3.6%	2.7	
Nemadji	858	40.9%	19.8%	8.2%	17.9%	5.4%	4.5%	3.3%	2.5	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 3-12. If wild, free-ranging elk are restored within the study areas in Minnesota, how much perceived control does respondent have to… Limit elk damage to own trees and forest vegetation?

	n	No Control		Moderate Control			Complete Control		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,408**	**41.4%**	**21.7%**	**11.3%**	**15.7%**	**4.6%**	**3.0%**	**2.3%**	**2.4**	
Cloquet Valley	793	40.2%	22.2%	12.4%	15.8%	3.9%	3.0%	2.4%	2.4	F = 3.21 *
Fond du Lac	758	39.4%	21.5%	11.2%	16.8%	5.4%	3.2%	2.5%	2.4	η^2 = .002
Nemadji	857	45.4%	21.1%	10.0%	14.2%	4.6%	2.7%	2.0%	2.3	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 3-13. If wild, free-ranging elk are restored within the study areas in Minnesota, how much perceived control does respondent have to… Limit impact of elk to deer and other wildlife in the study areas?

	n	No Control		Moderate Control			Complete Control		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,406**	**47.1%**	**24.2%**	**9.8%**	**12.9%**	**3.5%**	**1.3%**	**1.3%**	**2.1**	
Cloquet Valley	793	46.9%	24.4%	10.2%	12.6%	3.4%	1.5%	1.0%	2.1	F = .19 n.s.
Fond du Lac	755	45.8%	25.5%	9.7%	12.6%	3.8%	1.2%	1.5%	2.1	
Nemadji	858	48.9%	22.4%	9.3%	13.7%	3.0%	1.4%	1.3%	2.1	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 3-14. If wild, free-ranging elk are restored within the study areas in Minnesota, how much perceived control does respondent have to… Influence elk management decisions in study areas?

	n	No Control		Moderate Control			Complete Control		Mean	ANOVA
		1	2	3	4	5	6	7		
Landowners	**2,410**	**33.3%**	**23.7%**	**14.3%**	**19.2%**	**5.0%**	**2.6%**	**2.0%**	**2.5**	
Cloquet Valley	793	30.7%	24.2%	14.5%	20.9%	5.0%	2.5%	2.3%	2.6	F = 1.42 n.s.
Fond du Lac	758	34.0%	23.9%	14.9%	18.1%	4.7%	2.5%	1.8%	2.5	
Nemadji	859	35.3%	22.8%	13.5%	18.9%	5.1%	2.7%	1.7%	2.5	
Local Residents	**1,520**	**39.5%**	**23.7%**	**12.9%**	**14.4%**	**6.3%**	**1.9%**	**1.4%**	**2.4**	
Carlton	356	40.2%	19.7%	16.6%	15.7%	5.3%	0.8%	1.7%	2.4	
Duluth	343	33.4%	27.3%	15.1%	16.0%	6.4%	0.9%	0.9%	2.4	F = .66 n.s.
Pine	376	33.7%	24.1%	16.7%	13.5%	8.8%	1.9%	1.3%	2.5	
St Louis	435	32.9%	30.1%	13.3%	15.2%	4.8%	2.8%	0.9%	2.4	

[1]All results reflect weighted values correcting for stratification, gender, and age.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Section 4. Knowledge about Elk in Minnesota

Landowners and local residents were asked three questions to estimate their knowledge of elk in Minnesota. Each question contained a factual statement about elk in Minnesota and respondents were asked whether they knew this information prior to receiving the questionnaire. A scale of 0 to 3 was used based on the number of statements that the respondent knew prior to receiving the questionnaire. On average, landowners ($\bar{x}$ = 1.9) and local residents ($\bar{x}$ = 1.5) had moderate knowledge of elk in Minnesota (Table 4-1). Knowledge about elk was not significantly different between strata for landowners (F = 2.23, *n.s.*), though there was a significant difference between strata for local residents (F = 8.63, $p < .001$), with Duluth residents having less knowledge about elk in Minnesota on average.

We also examined knowledge of elk among hunters and non-hunters (Table 4-2). Respondents were determined to be hunters if they had participated in deer hunting and/or other hunting or trapping activities in the last 12 months. As expected, hunters had significantly more knowledge about elk in Minnesota than non-hunters among landowners (F = 305.70, $p < .001$) and local residents (F = 252.00, $p < .001$). On average, hunters had moderate knowledge of elk in Minnesota (landowners: $\bar{x}$ = 2.2; local residents: $\bar{x}$ = 2.0) and non-hunters had lower knowledge levels (landowners: $\bar{x}$ = 1.3; local residents: $\bar{x}$ = 1.1).

Table 4-1. Prior knowledge of elk in Minnesota.

	n	Question # (% Yes)			Mean[2]	ANOVA
		1	2	3		
Landowners	**2,505**	**70.7%**	**60.7%**	**58.1%**	**1.9**	
Cloquet Valley	825	69.9%	57.6%	56.9%	1.9	$F = 2.23^{n.s.}$
Fond du Lac	777	71.5%	58.4%	58.8%	1.9	$\eta^2 = .002$
Nemadji	903	70.6%	67.0%	59.0%	2.0	
Local Residents	**1,535**	**60.0%**	**34.0%**	**33.5%**	**1.5**	
Carlton	363	58.5%	42.1%	38.1%	1.5	
Duluth	348	58.6%	27.7%	29.5%	1.3	$F = 8.63^{***}$ $\eta^2 = .017$
Pine	385	62.0%	42.9%	39.3%	1.5	
St Louis	434	67.6%	43.7%	38.5%	1.7	

[1]All results reflect weighted values correcting for stratification, gender, and age.
Question 1: Did you know that wild, free-ranging elk historically lived in most of Minnesota?
Question 2: Did you know that approximately 100 wild, free-ranging elk live in northwest Minnesota?
Question 3: Did you know that wild, free-ranging elk have previously been restored to parts of northwest Minnesota?
[2] Mean based on number of correct responses on three questions: 0 = zero correct, 1 = one correct, 2 = two correct, 3 = three correct
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 4-2. Prior knowledge of elk in Minnesota among hunters and non-hunters.

	n	Question # (% Yes)			Mean[1]	ANOVA
		1	2	3		
Landowners	**2,505**	**70.7%**	**60.7%**	**58.2%**	**1.9**	F = 305.70 *** η^2 = .109
Hunter	1,694	77.2%	73.7%	67.3%	2.2	
Non-Hunter	811	57.4%	37.3%	40.6%	1.3	
Local Residents	**1,530**	**60.0%**	**34.0%**	**33.5%**	**1.5**	F = 252.00 *** η^2 = .142
Hunter	678	77.6%	64.9%	60.4%	2.0	
Non-Hunter	852	54.2%	30.5%	27.3%	1.1	

Question 1: Did you know that wild, free-ranging elk historically lived in most of Minnesota?
Question 2: Did you know that approximately 100 wild, free-ranging elk live in northwest Minnesota?
Question 3: Did you know that wild, free-ranging elk have previously been restored to parts of northwest Minnesota?
[2] Mean based on number of correct responses on three questions: 0 = zero correct, 1 = one correct, 2 = two correct, 3 = three correct
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Section 5. Importance of Elk in Minnesota

Landowners and local residents were asked three questions to indicate the importance to the respondent of restoring wild, free-ranging elk to the study areas in Minnesota. A 7-point scale from "strongly disagree" (1) to "strongly agree" (7) was used to indicate respondents' agreement with each statement. Respondents were asked whether they agree or disagree with the statement "it is important that Minnesota someday have an abundant elk population within the study areas" (Table 5-1). A majority of landowners (64%) and local residents (69%) agreed that having an abundant elk population within the study areas is important. Responses among landowners ($F = 7.37$, $p < .001$) and local residents ($F = 6.03$, $p < .001$) varied significantly across the study strata with Fond du Lac landowners indicating less importance than landowners in other areas, and Carlton County residents indicating less importance than local residents in other areas.

Respondents were asked whether they agree or disagree with the statement "whether or not I would get to see an elk, it is important to me that they could exist within the study areas" (Table 5-2). A majority of landowners (70%) and local residents (76%) agreed that having elk within the study areas is important to them. Responses among landowners ($F = 6.51$, $p < .01$) and local resident ($F = 8.31$, $p < .001$) varied significantly across the strata, with a slightly smaller percentage (although still more than 67%) of Fond du Lac landowners and Carlton County residents agreeing than other respondents.

Respondents were asked whether they agree or disagree with the statement "it is important to establish elk populations within the study areas so future generations can enjoy them" (Table 5-3). A majority of landowners (73%) and local residents (79%) agreed that establishing an elk population within the study areas for the enjoyment of future generations was important to the respondent. Responses among landowners ($F = 8.18$, $p < .001$) and local residents ($F = 9.39$, $p < .001$) varied significantly between strata, with a smaller percentage of Fond du Lac landowners (69%) agreeing than Cloquet Valley (75%) or Nemadji landowners (74%). Local residents in Carlton County (69%) were less likely to agree with the statement than residents in Duluth (81%), Pine County (81%), or St. Louis County (83%).

Table 5-1. Important that Minnesota someday have an abundant elk population within the study areas.

	n	Strongly disagree	Moderately disagree	Slightly disagree	Neither	Slightly agree	Moderately agree	Strongly agree	Mean[2]	ANOVA
Landowners	**2,443**	**7.8%**	**6.8%**	**5.3%**	**16.2%**	**18.8%**	**24.2%**	**20.9%**	**4.9**	
Cloquet Valley	804	6.2%	6.6%	4.2%	16.5%	17.7%	26.4%	22.4%	5.0	F = 7.37 *** η^2 = .007
Fond du Lac	764	9.1%	7.4%	6.8%	16.4%	19.6%	23.9%	16.7%	4.7	
Nemadji	875	7.9%	6.3%	4.9%	15.4%	19.3%	22.1%	24.0%	4.9	
Local Residents	**1,527**	**4.5%**	**5.0%**	**4.0%**	**17.5%**	**25.3%**	**25.0%**	**18.6%**	**5.0**	
Carlton	357	8.9%	5.3%	5.6%	17.3%	27.9%	22.6%	12.3%	4.7	
Duluth	345	2.6%	5.2%	3.2%	16.5%	25.8%	26.1%	20.6%	5.2	F = 6.03 *** η^2 = .007
Pine	379	5.5%	4.2%	4.2%	21.1%	18.5%	26.1%	20.3%	5.0	
St Louis	436	6.2%	4.1%	4.6%	16.3%	27.1%	23.6%	18.1%	5.0	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2] Mean based on scale: 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 5-2. Whether or not respondent gets to see an elk, it is important to them that elk could exist within the study areas.

	N	Strongly disagree	Moderately disagree	Slightly disagree	Neither	Slightly agree	Moderately agree	Strongly agree	Mean[1]	ANOVA
Landowners	**2,441**	**7.4%**	**5.1%**	**3.4%**	**13.9%**	**19.7%**	**24.2%**	**26.4%**	**5.1**	
Cloquet Valley	805	6.3%	4.7%	1.9%	13.4%	19.8%	25.7%	28.3%	5.2	F = 6.51 ** η^2 = .005
Fond du Lac	762	8.6%	5.2%	4.8%	14.3%	21.5%	23.2%	22.4%	4.9	
Nemadji	874	7.1%	5.4%	3.2%	14.0%	17.6%	23.7%	29.1%	5.2	
Local Residents	**1,518**	**4.4%**	**4.0%**	**2.7%**	**13.3%**	**21.8%**	**28.0%**	**25.8%**	**5.3**	
Carlton	357	8.7%	4.5%	4.2%	14.6%	23.6%	25.6%	18.8%	4.9	
Duluth	343	2.9%	4.3%	2.3%	12.2%	21.4%	29.6%	27.2%	5.4	F = 8.31 *** η^2 = .010
Pine	375	5.0%	2.1%	1.6%	17.5%	22.5%	26.7%	24.6%	5.3	
St Louis	433	4.1%	3.7%	2.5%	11.5%	22.7%	25.5%	30.0%	5.4	

[1] Mean based on scale: 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 5-3. Important to establish elk populations within the study areas so future generations can enjoy them.

	n	Strongly disagree	Moderately disagree	Slightly disagree	Neither	Slightly agree	Moderately agree	Strongly agree	Mean[2]	ANOVA
Landowners	**2,444**	**7.3%**	**4.9%**	**2.9%**	**12.3%**	**17.5%**	**24.5%**	**30.6%**	**5.2**	
Cloquet Valley	806	5.9%	4.5%	2.5%	12.1%	16.1%	25.0%	33.9%	5.3	F = 8.18 *** η^2 = .007
Fond du Lac	764	8.5%	5.8%	3.5%	12.9%	19.7%	24.6%	25.0%	5.0	
Nemadji	874	7.4%	4.3%	2.9%	11.7%	16.6%	23.9%	33.2%	5.3	
Local Residents	**1,517**	**4.4%**	**2.6%**	**3.7%**	**11.1%**	**20.5%**	**28.8%**	**29.2%**	**5.4**	
Carlton	356	9.0%	3.4%	3.1%	15.2%	21.1%	25.0%	23.3%	5.0	F = 9.39 *** η^2 = .011
Duluth	342	2.3%	2.3%	4.7%	10.2%	20.1%	29.1%	31.4%	5.6	
Pine	376	4.7%	1.8%	2.1%	10.8%	21.4%	31.7%	27.4%	5.5	
St Louis	433	3.7%	3.2%	1.8%	8.5%	19.7%	33.9%	29.3%	5.6	

[1]All results reflect weighted values correcting for stratification, gender, and age.

[2] Mean based on scale: 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree

F compares strata within study areas.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Section 6. Trust in Wildlife Managers

Respondents were asked to rate their agreement with three statements addressing their trust in wildlife managers using a strongly disagree (1) to strongly agree (5) scale. On average, landowners and local residents had similar levels of agreement for each trust statement. A majority of landowners (55%) and local residents (58%) agreed or strongly agreed that wildlife managers would be open and honest in the things they do and say when making elk management decisions (Table 6-1). A majority of landowners (51%) and local residents (60%) agreed that wildlife managers can be trusted to make decisions about elk management that are good for the resource, although Duluth residents agreed significantly more with the statement ($F = 7.75$, $p < .001$) (Table 6-2). Approximately half of landowners (49%) and 58% of local residents agreed or strongly agreed that wildlife managers will make decisions about elk management in a way that is fair. Duluth and St. Louis County residents agreed significantly more with the statement ($F = 8.32$, $p < .001$) than other local residents (Table 6-3).

Table 6-1. Trust in wildlife managers: Agreement/disagreement that... When deciding about elk management, wildlife managers would be open and honest in the things they do and say.

	N	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Mean[2]	ANOVA
Landowners	**2,440**	**7.5%**	**11.1%**	**26.8%**	**35.1%**	**19.5%**	**3.5**	
Cloquet Valley	808	6.4%	11.1%	27.1%	33.4%	21.9%	3.5	$F = 1.73$ n.s.
Fond du Lac	758	7.7%	10.7%	29.6%	35.4%	16.8%	3.4	
Nemadji	874	8.6%	11.5%	23.3%	36.8%	19.8%	3.5	
Local Residents	**1,522**	**4.2%**	**7.6%**	**30.1%**	**37.1%**	**20.9%**	**3.6**	
Carlton	357	5.9%	8.4%	32.3%	35.4%	18.0%	3.5	
Duluth	343	2.9%	6.4%	29.3%	39.1%	22.3%	3.7	$F = 4.29$ ** $\eta^2 = .005$
Pine	377	3.9%	10.0%	29.7%	35.0%	21.3%	3.6	
St Louis	435	5.7%	11.0%	31.6%	35.0%	16.7%	3.5	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2]Mean based on scale: 1 = strongly disagree, 2 = disagree, 3 = neither, 4 = agree, 5 = strongly agree
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 6-2. Trust in wildlife managers: Agreement/disagreement that... Wildlife managers can be trusted to make decisions about elk management that are good for the resource.

	n	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Mean[2]	ANOVA
Landowners	**2,438**	**7.6%**	**11.8%**	**29.8%**	**38.4%**	**12.3%**	**3.4**	
Cloquet Valley	808	6.0%	12.1%	31.1%	37.3%	13.5%	3.4	$F = 1.51$ n.s.
Fond du Lac	758	8.3%	11.9%	31.1%	38.3%	10.4%	3.3	
Nemadji	872	8.7%	11.5%	26.8%	39.8%	13.2%	3.4	
Local Residents	**1,522**	**3.9%**	**7.7%**	**28.5%**	**44.9%**	**15.0%**	**3.6**	
Carlton	357	5.9%	11.0%	28.2%	43.9%	11.0%	3.4	
Duluth	343	2.6%	4.9%	28.1%	46.7%	17.7%	3.7	$F = 7.75$ *** $\eta^2 = .013$
Pine	377	3.2%	10.5%	34.7%	39.7%	11.8%	3.5	
St Louis	435	5.3%	12.2%	30.5%	40.6%	11.5%	3.4	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2]Mean based on scale: 1 = strongly disagree, 2 = disagree, 3 = neither, 4 = agree, 5 = strongly agree
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 6-3. Trust in wildlife managers: Agreement/disagreement that... Wildlife managers will make decisions about elk management in a way that is fair.

	n	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Mean[2]	ANOVA
Landowners	**2,439**	**7.6%**	**12.3%**	**31.5%**	**36.1%**	**12.4%**	**3.3**	
Cloquet Valley	807	5.4%	13.4%	32.5%	34.8%	13.9%	3.4	$F = 1.52$ n.s.
Fond du Lac	759	8.8%	11.3%	32.1%	37.7%	10.0%	3.3	
Nemadji	873	8.6%	12.1%	29.4%	36.4%	13.4%	3.3	
Local Residents	**1,518**	**4.4%**	**7.7%**	**30.0%**	**42.8%**	**15.2%**	**3.6**	
Carlton	357	7.6%	10.1%	30.1%	39.0%	13.2%	3.4	
Duluth	340	2.9%	5.0%	28.6%	46.1%	17.5%	3.7	$F = 8.32$ *** $\eta^2 = .018$
Pine	377	4.2%	11.1%	36.3%	37.9%	10.5%	3.4	
St Louis	434	5.5%	12.4%	32.6%	37.4%	12.2%	3.9	

[1]All results reflect weighted values correcting for stratification, gender, and age.
[2]Mean based on scale: 1 = strongly disagree, 2 = disagree, 3 = neither, 4 = agree, 5 = strongly agree
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Hunter/Non-Hunter

We examined whether hunters and non-hunters differed in their trust of wildlife managers (Table 6-4). Respondents were determined to be hunters if they had participated in deer hunting and/or other hunting or trapping activities in the last 12 months. Non-hunters were significantly more trusting of wildlife managers than hunters among landowners and local residents. Hunters and non-hunters slightly agreed with each trust statement.

Farmer/Non-Farmer

We examined whether farmers and non-farmers differed in their trust of wildlife managers (Table 6-5). Respondents were determined to be farmers if they indicated that a portion of their household income was derived from agricultural activities. Analysis was limited to landowners since questions related to agriculture activities were excluded from the local resident questionnaire. Among landowners, non-farmers were significantly more trusting of wildlife managers than farmers, though both groups only slightly agreed with each trust statement.

Table 6-4. Trust in wildlife managers among hunters and non-hunters.

	Landowners			Local Residents		
Trust statement	**Hunters**	**Non-hunters**	**ANOVA**	**Hunters**	**Non-hunters**	**ANOVA**
Statement 1	3.4 (n = 1,701)	3.6 (n = 739)	F = 9.24 ** η^2 = .004	3.4 (n = 672)	3.6 (n = 840)	F = 13.65 *** η^2 = .009
Statement 2	3.3 (n = 1,701)	3.5 (n = 737)	F = 17.13 *** η^2 = .007	3.3 (n = 672)	3.5 (n = 840)	F = 13.82 *** η^2 = .009
Statement 3	3.3 (n = 1,704)	3.5 (n = 735)	F = 16.36 *** η^2 = .007	3.3 (n = 671)	3.5 (n = 837)	F = 14.25 *** η^2 = .009

Mean based on scale: 1 = strongly disagree, 2 = disagree, 3 = neither, 4 = agree, 5 = strongly agree
F compares hunters and non-hunters.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 6-5. Trust in wildlife managers among farmers and non-farmers.

	Landowners		
Trust statement	**Farmers**	**Non-farmers**	**ANOVA**
Statement 1	3.4 (n = 409)	3.5 (n = 1,951)	F = 4.72 * η^2 = .002
Statement 2	3.2 (n = 408)	3.4 (n = 1,952)	F = 19.63 *** η^2 = .008
Statement 3	3.1 (n = 409)	3.4 (n = 1,952)	F = 20.55 *** η^2 = .009

Mean based on scale: 1 = strongly disagree, 2 = disagree, 3 = neither, 4 = agree, 5 = strongly agree
F compares farmers and non-farmers.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Section 7. Elk-Related Recreation

Wildlife-Viewing

Respondents were asked about interest in participating in elk-related recreation if an elk population is restored to the study areas in Minnesota, including wildlife viewing and hunting. Landowners and local residents were asked how likely they would be to make a trip to view, photograph or hear elk within the study areas in Minnesota (Table 7-1). Likelihood of making a trip to view, photograph or hear elk was assessed using a 7-point scale from "very unlikely" (1) to "very likely" (7). On average, landowners ($\bar{x}$ = 4.6) and local residents ($\bar{x}$ = 4.7) indicated that there would be slight likelihood of them making a trip to view, photograph or hear elk. Over 60% of landowners (61%) and local residents (64%) indicated that they would likely make a trip to view, photograph or hear elk. There was no significant difference in the likelihood of making a trip for viewing, photographing or hearing elk between strata for landowners (F = 2.91) but Pine County residents (70%) were more likely to take such a trip than other local residents (F = 4.53, $p < .01$). Over 40% of both landowners (46%) and local residents (41%) indicated that they had ever visited a National Park or similar destination in North America for which an important part of the trip was viewing, photographing or hearing elk.

Table 7-1. Likelihood of making trip for which viewing, photographing or hearing elk is an important part of the trip.

	N	Very unlikely	Quite unlikely	Slightly unlikely	Unsure	Slightly likely	Quite likely	Very likely	Mean[2]	ANOVA
Landowners	**2,436**	**12.8%**	**8.9%**	**6.2%**	**10.9%**	**18.8%**	**23.2%**	**19.1%**	**4.6**	
Cloquet Valley	804	12.9%	7.7%	5.7%	10.2%	20.6%	21.6%	21.4%	4.6	F = 2.91 n.s.
Fond du Lac	759	12.6%	10.8%	6.4%	12.9%	18.8%	22.4%	16.1%	4.5	
Nemadji	873	13.1%	8.2%	6.5%	9.4%	17.0%	26.0%	19.8%	4.7	
Local Residents	**1,517**	**9.7%**	**10.0%**	**4.7%**	**11.2%**	**19.5%**	**26.1%**	**18.7%**	**4.7**	
Carlton	357	12.0%	8.1%	5.9%	14.0%	20.9%	21.2%	17.9%	4.6	
Duluth	343	9.0%	11.0%	3.5%	11.3%	19.2%	28.2%	17.7%	4.8	F = 4.53 ** η^2 = .002
Pine	377	6.6%	6.3%	6.6%	10.5%	21.3%	21.3%	27.6%	5.1	
St Louis	434	10.8%	9.4%	7.1%	8.2%	18.1%	28.6%	17.8%	4.7	

[1]All results reflect weighted values correcting for stratification, gender, and age.

[2] Mean based on scale: 1 = very unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = unsure, 5 = slightly likely, 6 = quite likely, 7 = very likely

F compares strata within study areas.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Hunting

Landowners and local residents were asked whether they have hunted elk or applied for an elk license in Minnesota or elsewhere in North America (Table 7-2). Few landowners (2%) and very few local residents (0.2%) have applied for or have been drawn for an elk hunting license in Minnesota, although more respondents have hunted elk or applied to hunt elk elsewhere in North America (landowners: 21%; local residents: 8%). Less than one-quarter of landowners (24%) and fewer than 1 in 5 local residents (16%) indicated that they plan to apply for a Minnesota elk hunting license in the future. A majority of landowners (52%) and local residents (71%) did not plan to apply for a Minnesota elk hunting license in the future. In general, landowners were more likely than local residents to have applied for or have drawn an elk license or apply for one in the future. About 10% of landowners and 12% local residents indicated that they have lived in an area where elk where common.

Table 7-2. Hunted elk or applied for an elk license in Minnesota or elsewhere in North America.

	Landowners	Cloquet Valley	Fond du Lac	Nemadji	Local Residents	Carlton	Duluth	Pine	St Louis
Applied for or have drawn a Minnesota elk license	2.0% (n = 50)	1.4% (n = 12)	1.8% (n = 16)	3.0% (n = 27)	0.2% (n = 3)	0.3% (n = 2)	0% (n = 0)	0.3% (n = 2)	0.9% (n = 4)
Plan to apply for a Minnesota elk license in the future	23.6% (n = 601)	22.9% (n = 192)	22.0% (n = 177)	26.1% (n = 237)	16.2% (n = 255)	17.2% (n = 64)	11.5% (n = 34)	25.2% (n = 75)	29.1% (n = 105)
Do not plan to apply for a Minnesota elk license in the future	51.7% (n = 1,318)	54.5% (n = 452)	53.9% (n = 420)	46.0% (n = 417)	71.3% (n = 1,120)	67.8% (n = 249)	76.8% (n = 277)	61.1% (n = 251)	54.5% (n = 257)
Hunted elk or applied to hunt elk elsewhere in North America	21.2% (n = 540)	17.5% (n = 151)	21.1% (n = 176)	25.4% (n = 238)	7.8% (n = 123)	11.8% (n = 48)	4.5% (n = 20)	15.8% (n = 56)	10.5% (n = 45)
n	2,550	841	796	913	1,571	373	358	393	447

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Section 8. Outdoor Activities and Membership

Respondents were asked about their participation in outdoor recreation during the past 12 months (Table 8-1). Among landowners, the greatest proportion of respondents participated in: (1) fishing, (2) deer hunting, (3) ATV riding, and (4) hiking. Among local residents, the greatest proportion of respondents participated in: (1) fishing, (2) hiking, (3) wildlife watching and photography, and (4) feeding wildlife. As expected, participation in outdoor recreational activities was slightly lower among Duluth respondents.

Table 8-1. Participation in recreational activities.

	Landowners	Cloquet Valley	Fond du Lac	Nemadji	Local Residents	Carlton	Duluth	Pine	St. Louis
Deer hunting	62.9%	58.1%	59.7%	72.2%	30.4%	37.8%	20.9%	51.1%	46.8%
Other hunting or trapping	42.3%	39.0%	42.2%	46.2%	18.8%	23.9%	12.3%	33.6%	31.8%
Wildlife watching or photography	53.7%	54.5%	52.3%	54.7%	50.3%	45.0%	50.3%	56.2%	54.8%
Feeding wildlife	52.2%	49.3%	52.9%	54.7%	38.4%	40.5%	31.6%	49.9%	54.8%
Snowmobiling	27.2%	29.5%	27.0%	24.6%	22.9%	24.7%	20.4%	19.6%	34.2%
ATV riding	59.6%	57.2%	59.2%	62.9%	37.3%	46.4%	27.4%	53.9%	55.7%
Hiking	59.7%	60.2%	57.4%	62.0%	66.6%	57.1%	70.7%	59.0%	66.7%
Fishing	67.5%	69.0%	67.0%	66.4%	55.6%	57.6%	50.6%	61.3%	68.5%
RV or tent camping	40.2%	39.8%	41.8%	38.7%	42.8%	42.9%	41.6%	40.5%	48.1%
Cross-country skiing	13.5%	16.2%	11.9%	12.0%	19.0%	11.5%	22.9%	7.9%	19.5%
None	3.5%	3.8%	4.3%	2.3%	9.4%	7.5%	11.7%	5.3%	5.1%
Other	6.9%	8.8%	6.2%	5.8%	7.0%	4.3%	7.8%	6.1%	7.8%
N	**2,455**	**806**	**768**	**881**	**1,571**	**358**	**347**	**382**	**436**

[1]All results reflect weighted values correcting for stratification, gender, and age.
Respondents able to select multiple responses. Column totals may equal greater than 100%.

Respondents were asked about their membership in environmental, conservation, or hunting organizations (Table 8-2). Among landowners and local residents, the greatest proportion of respondents were members of: (1) local sporting clubs, (2) Minnesota Deer Hunters Association, and (3) Sierra Club. Overall, membership rates were relatively low with local residents having lower membership rates than landowners.

Table 8-2. Membership in outdoor organizations.

	Landowners	Cloquet Valley	Fond du Lac	Nemadji	Local Residents	Carlton	Duluth	Pine	St. Louis
Rocky Mountain Elk Foundation	3.2%	2.9%	3.3%	3.6%	.8%	2.1%	0.0%	2.3%	1.3%
Minnesota Deer Hunters Association	9.9%	6.1%	12.2%	11.6%	3.4%	7.8%	1.4%	8.1%	2.9%
Quality Deer Hunters Association	1.4%	0.2%	0.8%	3.5%	.2%	0.3%	0.0%	1.0%	0.0%
Local sporting club	11.1%	10.8%	10.3%	12.3%	8.0%	6.2%	7.8%	8.7%	10.3%
Sierra Club	7.3%	8.8%	4.6%	8.5%	4.3%	2.1%	4.5%	4.3%	6.3%
The Nature Conservancy	1.9%	2.3%	1.3%	2.1%	3.5%	1.1%	5.0%	0.5%	2.9%
National Audubon Society	3.9%	4.4%	3.5%	3.8%	4.3%	1.1%	5.0%	0.5%	2.9%
Other	2.8%	2.3%	2.5%	4.1%	2.3%	1.6%	2.0%	3.1%	4.3%
N	**2,550**	**841**	**796**	**913**	**1,571**	**373**	**358**	**393**	**447**

[1]All results reflect weighted values correcting for stratification, gender, and age.
Respondents able to select multiple responses. Column totals may equal greater than 100%.

Section 9. Landowner Property Characteristics

Property Type within Study Areas in Minnesota

Landowners were asked to describe their property within the study areas in Minnesota. Analysis was limited to landowners since questions related to property characteristics were excluded from the local resident questionnaire. In 2017, landowners owned 94.1 acres with Fond du Lac landowners having the largest property sizes (Cloquet Valley: $\bar{x}$ = 72.2; Fond du Lac: $\bar{x}$ = 113.2; Nemadji: $\bar{x}$ = 97.3 acres). Landowners indicated their property was used primarily as their primary residence (49%) or seasonal/recreational residence (47%) (Table 9-1). Property type proportions were significantly different between strata for primary residences, agricultural production, rental properties, and seasonal/recreational residences. A majority of properties within the Nemadji study area were considered seasonal/recreational residences (67%). Landowners that described their property as a seasonal or recreational residence spent about two months annually on the property (Table 9-2) and 45% indicated their full-time residence was in the 7-county Twin Cities metro (Hennepin, Ramsey, Dakota, Anoka, Washington, Scott, and Carver Counties).

Table 9-1. Property type within the study areas in Minnesota.

	n	Primary residence	Agricultural production	Rental property	Business property	Seasonal or recreational residence
Landowners	**2,431**	**48.5%**	**9.2%**	**2.2%**	**2.1%**	**46.8%**
Cloquet Valley	805	54.7%	6.2%	2.1%	2.1%	42.2%
Fond du Lac	749	59.9%	12.3%	3.3%	2.5%	33.8%
Nemadji	877	28.1%	9.1%	1.0%	1.6%	67.1%
χ^2		χ^2 = 186.73 *p* < .001 V = .27	χ^2 = 21.40 *p* < .001 V = .09	χ^2 = 9.87 *p* < .01 V = .06	χ^2 = 1.67 *p* = .43 V = .03	χ^2 = 197.75 *p* < .001 V = .28

[1]All results reflect weighted values correcting for stratification on property size and population in each study area. Respondents able to select multiple responses. Row totals may equal greater than 100%.

Table 9-2. Mean number of months residing at seasonal or recreational property.

	n	Months Residing at Property	ANOVA
Landowners	**928**	**2.1**	F = .53 n.s.
Cloquet Valley	282	2.2	
Fond du Lac	198	2.0	
Nemadji	448	2.1	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area. Respondents that indicated property is seasonal or recreational property and resided there fewer than 12 months per year. F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Land Use Activities

Landowners were asked to indicate activities that occurred on their property within the past 5 years (Table 9-3). The most common land use activities reported by respondents were: (1) hunting (78%); (2) residential use (55%); (3) timber production (23%); and (4) hay production (22%). Row crops (corn, beans) (6%), small grains (wheat, oats) (6%), and commercial/Industrial use (2%) were the least common activities. Properties in the Nemadji study area were more likely to be used for hunting and less likely for residential use.

Respondents were also asked to what extent their property was currently being used for a variety of activities. A majority of respondents indicated that at least some of their property was used for private residence, such as houses, lawns, and associated buildings (62%) (Table 9-4). Private residences were significantly more common ($F = 25.05$, $p < .001$) in the Cloquet Valley (68%) and Fond du Lac (67%) study areas than the Nemadji study area (51%). Woodlands, such as natural forest and tree plantings, were the most common habitat type with 84% of respondents indicating at least some of their property contained woodlands (Table 9-5). Woodlands were significantly more common among landowners within the Nemadji study area ($F = 35.55$, $p < .001$). Wetlands, including alder swamp and marsh, was also a common habitat type with 69% of respondents indicating at least some of their property contained wetlands (Table 9-6). Less than half of respondents (45%) indicated that at least some of their property was brushland, including abandoned, overgrown fields (Table 9-7). About one-quarter of respondents indicated that they improve wildlife habitat on their property by creating wildlife food plots (25%) (Table 9-8).

Hayfields (28%) (Table 9-9) and livestock pasture (12%) (Table 9-10) were the most common agricultural land types among respondents. Hayfields ($F = 28.52$, $p < .001$) and livestock pasture ($F = 4.413$, $p < .01$) were significantly more common within the Fond du Lac study area. Small grains (5%) (Table 9-11), row crops (5%) (Table 9-12), and other property types (6%) (Table 9-13) were present on a limited number of properties. Small grains ($F = 4.56$, $p < .01$) and row crops ($F = 11.03$, $p < .001$) were significantly less common among landowners within the Nemadji study area.

Table 9-3. Land use activities taking place on property.

	n	Row crops (corn, beans)	Small grains (wheat, oats)	Hay production	Livestock grazing	Timber production	Maple syrup production	Residential use	Commercial / Industrial use	Hunting	Other
Landowners	**2,550**	**6.2%**	**5.9%**	**21.7%**	**11.0%**	**22.7%**	**7.6%**	**55.1%**	**2.1%**	**77.9%**	**8.9%**
Cloquet Valley	841	4.4%	3.4%	16.2%	9.3%	22.2%	5.7%	61.7%	1.4%	74.1%	9.6%
Fond du Lac	796	6.3%	7.9%	30.9%	14.3%	21.7%	9.4%	62.2%	3.1%	75.3%	8.0%
Nemadji	913	8.2%	6.2%	17.3%	9.0%	24.5%	7.8%	39.4%	1.5%	85.4%	9.1%

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.

Table 9-4. Property land type: Private residence (house, lawns, associated buildings).

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**37.7%**	**48.9%**	**4.1%**	**9.3%**	
Cloquet Valley	827	32.3%	52.5%	4.4%	10.8%	$F = 25.05$ ***
Fond du Lac	771	33.4%	51.4%	5.3%	9.9%	$\eta^2 = .017$
Nemadji	901	48.8%	42.0%	2.3%	6.9%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-5. Property land type: Woodlands (natural forest or tree plantings).

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**15.6%**	**25.5%**	**45.2%**	**13.6%**	
Cloquet Valley	827	16.2%	25.8%	45.3%	12.7%	$F = 35.55$ ***
Fond du Lac	771	19.2%	30.2%	40.9%	9.7%	$\eta^2 = .027$
Nemadji	901	10.8%	20.0%	50.1%	19.2%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-6. Property land type: Wetlands (including alder swamp & marsh).

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**31.3%**	**58.2%**	**8.3%**	**2.2%**	
Cloquet Valley	827	32.8%	56.7%	8.3%	2.2%	$F = 1.46$ n.s.
Fond du Lac	771	32.0%	57.7%	7.9%	2.3%	
Nemadji	901	28.9%	60.3%	8.7%	2.2%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-7. Property land type: Brushland (including abandoned, overgrown fields).

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**54.8%**	**35.6%**	**7.1%**	**2.4%**	
Cloquet Valley	827	55.1%	35.1%	7.7%	2.1%	F = .93 n.s.
Fond du Lac	771	52.5%	38.1%	6.9%	2.6%	
Nemadji	901	57.2%	33.4%	6.8%	2.7%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-8. Property land type: Wildlife food plots.

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**74.9%**	**22.3%**	**1.6%**	**1.2%**	
Cloquet Valley	827	81.4%	16.5%	1.1%	1.1%	F = 14.66 ***
Fond du Lac	771	74.2%	23.3%	1.3%	1.2%	η^2 = .013
Nemadji	901	68.5%	27.6%	2.7%	1.2%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-9. Property land type: Hayfields.

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**72.5%**	**20.5%**	**5.6%**	**1.3%**	
Cloquet Valley	827	78.0%	16.8%	4.2%	1.0%	F = 28.52 ***
Fond du Lac	771	62.4%	27.5%	8.4%	1.7%	η^2 = .023
Nemadji	901	77.8%	16.8%	4.1%	1.3%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-10. Property land type: Livestock pasture.

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**87.7%**	**9.1%**	**2.2%**	**1.0%**	
Cloquet Valley	827	89.6%	7.9%	1.8%	0.7%	F = 4.43 **
Fond du Lac	771	84.3%	11.8%	2.7%	1.2%	η^2 = .004
Nemadji	901	89.6%	7.3%	2.1%	1.0%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-11. Property land type: Small grains (wheat, oats).

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**94.7%**	**4.0%**	**.8%**	**.5%**	
Cloquet Valley	827	97.2%	2.3%	0.2%	0.2%	F = 4.56 **
Fond du Lac	771	96.4%	3.2%	0.3%	0.1%	η^2 = .004
Nemadji	901	92.5%	6.1%	0.9%	0.6%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-12. Property land type: Row crops (corn, beans).

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**95.4%**	**3.8%**	**.5%**	**.3%**	
Cloquet Valley	827	97.2%	2.3%	0.2%	0.2%	F = 11.03 ***
Fond du Lac	771	96.4%	3.2%	0.3%	0.1%	η^2 = .009
Nemadji	901	92.5%	6.1%	0.9%	0.6%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 9-13. Property land type: Other.

	n	None	Some	Most	All	ANOVA
Landowners	**2,499**	**94.1%**	**4.8%**	**.6%**	**.6%**	
Cloquet Valley	827	93.1%	5.7%	0.6%	0.6%	F = 1.09 n.s.
Fond du Lac	771	94.0%	4.8%	0.6%	0.5%	
Nemadji	901	95.2%	3.7%	0.6%	0.6%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.
F compares strata within study areas.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Section 10. Demographic Characteristics of Landowners and Local Residents

As described in the introduction, data were weighted to correct for disproportionate sampling on property size and population size across the study areas as well as gender and age among local residents to reflect known proportions for gender and age categories base on the U.S. Census figures. After weighting for property size, landowners ($\bar{x}$ = 60.2 years) were older than the weighted sample of local residents ($\bar{x}$ = 49.4 years) (Table 10-1). The age of local residents, after weighting, varied significantly across strata with Duluth residents having a slightly younger mean age (5.65, $p < .001$), but landowners did not vary significantly among strata (F = .89, *n.s.*). On average, landowners in the sample have lived in Minnesota ($\bar{x}$ = 54.0 years) longer than local residents ($\bar{x}$ = 42.8 years), although both groups have lived in Minnesota a majority of their lives (90% vs 87%) (Table 10-2). Landowners owned property in northeastern Minnesota ($\bar{x}$ = 23.6 years) longer on average than local residents that owned their current residence ($\bar{x}$ = 14.0 years) (Table 10-3). On average, local residents that rent their current residence have resided there 7.1 years. About 90% of local residents indicated that they owned their current residence, although ownership rates varied significantly among strata with 98% of St. Louis respondents owning their residence (Table 10-4). A majority of responding landowners and local residents were male (82% vs 66%, respectively), but after weighting 51% of the local resident respondents were male (Table 10-5). Overall, a majority of landowners (53%) and local resident (65%) respondents have at least attended some college (Table 10-6). On average, the household income of landowners was greater than local residents ($98,667 vs $77,839) (Table 10-7). Although more than a quarter of landowners reported hayfields on their property, less than 20% of landowners (17%) indicated that at least a portion of their household income was derived from farming which suggests that for some respondents farming activity does not lead to claimed income (Table 10-8). About half of landowners (51%) but fewer local residents (42%) were raised primarily in a rural area as a youth, either on a farm or not (Table 10-9).

Table 10-1. Respondent age.

	n	Mean	ANOVA
Landowners[a]	**2,446**	**60.2**	
Cloquet Valley	803	60.2	F = .89 n.s.
Fond du Lac	759	59.9	
Nemadji	884	60.8	
Local Residents[b]	**1,495**	**49.4**	
Carlton	353	50.4	
Duluth	341	47.9	F = 5.65***
Pine	377	51.6	
St Louis	424	52.9	

[a]Data weighted to reflect population proportions of landowners with 10 to 40 acres, and >40 acres in the total study area and individual area strata.

[b]Data weighted using U.S. Census information to reflect age and gender distributions of study area for the general public in total study area and individual area strata.

F compares strata within each study area.

n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 10-2. Years lived in Minnesota.

	n	Mean number of years	% of life	ANOVA
Landowners[a]	**2,465**	**54.0**	**90.0%**	
Cloquet Valley	807	52.5	87.7%	F = 6.23 **
Fond du Lac	765	55.0	91.8%	η^2 = .004
Nemadji	893	54.8	90.6%	
Local Residents[b]	**1,530**	**42.8**	**86.6%**	
Carlton	360	45.7	89.9%	F = 9.99 ***
Duluth	345	40.3	83.7%	η^2 = .012
Pine	380	46.6	89.4%	
St Louis	435	47.0	88.9%	

[a]Data weighted to reflect population proportions of landowners with 10 to 40 acres, and >40 acres in the total study area and individual area strata.
[b]Data weighted using U.S. Census information to reflect age and gender distributions of study area for the general public in total study area and individual area strata.
F compares strata within each study area.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 10-3. Length of property ownership/rental in northwest Minnesota.

	n	Mean number of years	% of life	ANOVA
Landowners	**2,396**	**23.6**	**37.6%**	
Cloquet Valley	782	24.4	38.8%	F = 5.18 **
Fond du Lac	740	24.6	39.4%	η^2 = .005
Nemadji	874	22.2	35.2%	
Local Residents	**1,503**	**14.0**	**31.3%**	
Carlton	356	15.1	30.6%	F = 8.80 ***
Duluth	339	12.6	28.1%	η^2 = .009
Pine	378	16.0	31.9%	
St Louis	427	17.7	33.9%	

F compares strata within each study area.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 10-4. Ownership or rental of current residence among local residents.

	n	Own	Rent	χ^2
Local Residents	**1,513**	**89.7%**	**10.3%**	$\chi^2 = 18.58$ *** V = .12
Carlton	357	90.2%	9.8%	
Duluth	343	87.6%	12.4%	
Pine	383	88.7%	1.3%	
St Louis	430	98.4%	1.6%	

χ^2 compares strata within each study area.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 10-5. Respondent gender.

	n	Male	Female	Other / Rather not identify	χ^2
Landowners[a]	**2,472**	**81.0%**	**17.9%**	**1.1%**	$\chi^2 = 13.38$ ** V = .05
Cloquet Valley	811	79.1%	19.9%	1.0%	
Fond du Lac	770	79.4%	19.2%	1.4%	
Nemadji	891	85.3%	13.9%	0.8%	
Local Residents[b]	**1,520**	**50.6%**	**48.7%**	**.7%**	$\chi^2 = 41.11$ *** V = .12
Carlton	363	51.0%	47.1%	1.9%	
Duluth	344	49.4%	50.3%	0.3%	
Pine	382	54.2%	45.3%	0.5%	
St Louis	431	53.8%	45.9%	0.2%	

[a]Data weighted to reflect population proportions of landowners with 10 to 40 acres, and >40 acres in the total study area and individual area strata.
[b]Data weighted using U.S. Census information to reflect age and gender distributions of study area for the general public in total study area and individual area strata.
χ^2 compares strata within each study area.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 10-6. Respondent education.

	n	GS	Some HS	HS degree	Some vo-tech	Vo-tech degree	Some college	4 yr. degree	Some grad. school	Grad. degree
Landowners[a]	**2,460**	**.2%**	**1.4%**	**17.6%**	**10.2%**	**17.6%**	**19.1%**	**18.1%**	**3.7%**	**12.0%**
Cloquet Valley	808	0.1%	1.9%	15.5%	8.9%	17.6%	17.9%	19.8%	4.3%	14.1%
Fond du Lac	763	0.4%	0.9%	19.7%	10.5%	18.6%	18.8%	17.4%	2.9%	10.8%
Nemadji	889	0.2%	1.5%	17.5%	11.6%	16.7%	20.7%	17.0%	3.9%	10.8%
Local Residents[b]	**1,505**	.1%	.9%	12.0%	7.5%	14.1%	18.1%	28.5%	3.4%	15.3%
Carlton	355	0.0%	1.4%	17.2%	7.9%	17.5%	19.7%	18.9%	5.1%	12.4%
Duluth	342	0.0%	0.6%	7.6%	6.4%	10.2%	18.6%	35.2%	3.5%	18.0%
Pine	375	1.1%	2.4%	18.4%	12.2%	25.3%	17.6%	13.8%	1.9%	7.4%
St Louis	426	0.2%	0.5%	17.4%	9.1%	17.7%	17.7%	23.3%	1.9%	12.3%

[a]Data weighted to reflect population proportions of landowners with 10 to 40 acres, and >40 acres in the total study area and individual area strata

[b]Data weighted using U.S. Census information to reflect age and gender distributions of study area for the general public in total study area and individual area strata.

Table 10-7. Gross annual household income.

	n	Mean	ANOVA
Landowners	**2,173**	**$98,666.59**	
Cloquet Valley	708	$98,040.25	F = 8.23 ***
Fond du Lac	691	$91,953.69	η^2 = .008
Nemadji	774	$105,232.56	
Local Residents	**1,371**	**$77,839.17**	
Carlton	330	$81,219.70	
Duluth	306	$74,493.46	F = 4.76 **
Pine	338	$70,584.32	η^2 = .010
St Louis	397	$83,784.63	

Assigned median value for each response category. Value of $250,000 used for "$200,000 or more" responses.
F compares strata within each study area.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 10-8. Total household income from farming.

	n	None	1-25%	26-50%	51-75%	76-100%	χ^2
Landowners	**2,389**	**83.3%**	**13.9%**	**1.9%**	**0.3%**	**0.7%**	
Cloquet Valley	788	86.5%	11.3%	1.6%	0.1%	0.5%	$\chi^2 = 4.65$ ** V = .00
Fond du Lac	748	80.8%	15.3%	3.1%	0.1%	0.7%	
Nemadji	853	82.6%	15.2%	0.8%	0.7%	0.7%	

[1]All results reflect weighted values correcting for stratification on property size and population in each study area.χ^2 compares strata within each study area.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

Table 10-9. Primary area respondent was raised as youth.

	n	Rural on a farm	Rural non-farm	Small town	Suburb	City	χ^2
Landowners[a]	**2,390**	**28.6%**	**22.8%**	**18.9%**	**13.7%**	**16.0%**	
Cloquet Valley	781	23.5%	26.9%	19.8%	11.5%	18.3%	$\chi^2 = 123.50$ *** V = .16
Fond du Lac	747	36.9%	25.1%	17.8%	9.9%	10.3%	
Nemadji	862	24.5%	15.5%	19.1%	20.5%	20.3%	
Local Residents[b]	**1,498**	**16.8%**	**25.1%**	**21.0%**	**12.4%**	**24.6%**	
Carlton	354	21.6%	26.7%	32.4%	7.7%	11.6%	
Duluth	342	10.3%	22.6%	18.2%	15.0%	34.0%	$\chi^2 = 203.90$ *** V = .21
Pine	371	31.7%	25.3%	19.5%	12.0%	11.5%	
St Louis	428	25.9%	34.8%	19.4%	7.2%	12.6%	

[a]Data weighted to reflect population proportions of landowners with 10 to 40 acres, and >40 acres in the total study area and individual area strata.
[b]Data weighted using U.S. Census information to reflect age and gender distributions of study area for the general public in total study area and individual area strata.
χ^2 compares strata within each study area.
n.s. = not significant, *p < 0.05, **p< 0.01, ***p< 0.001

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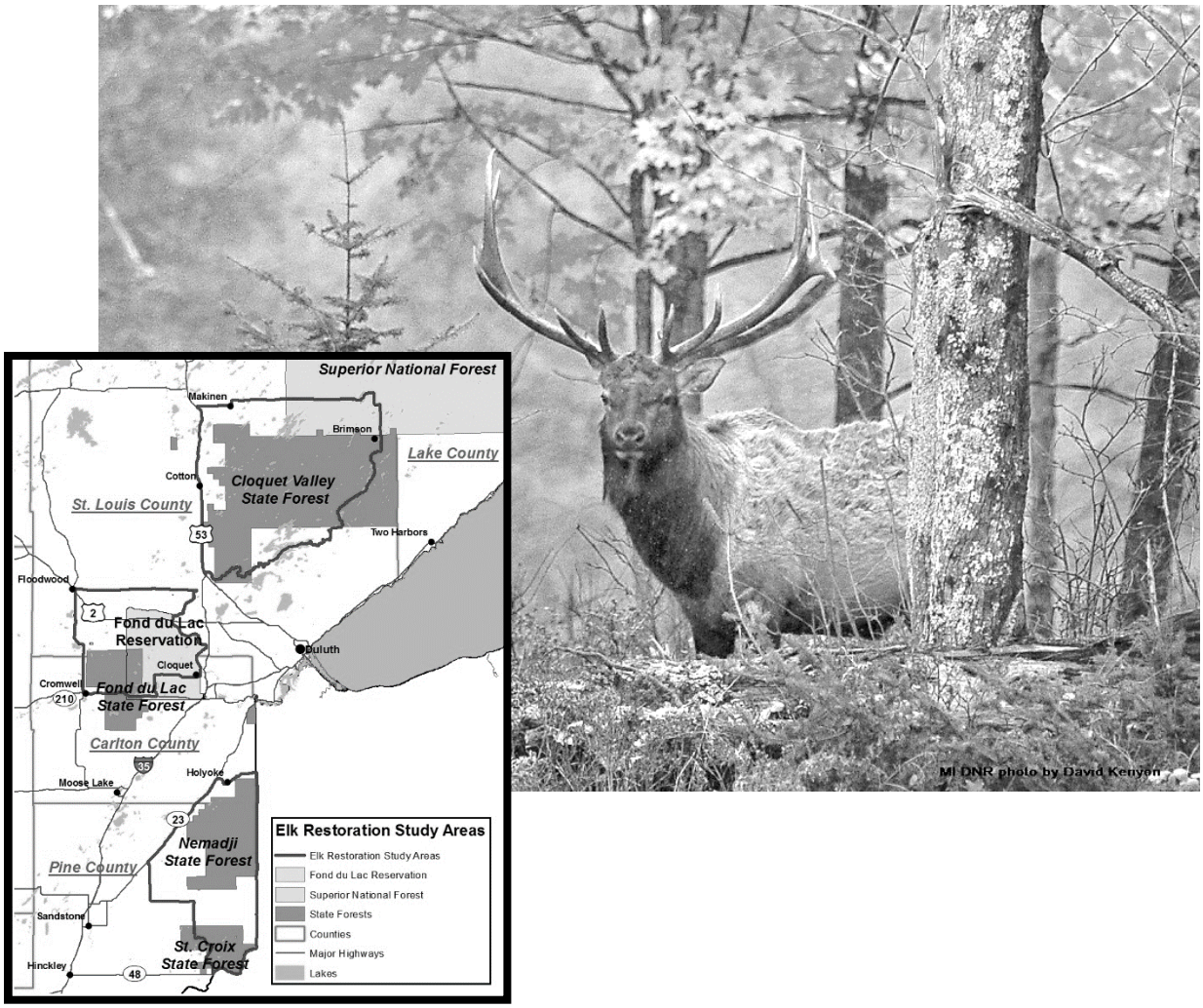
Appendix A:
Landowner Attitudes toward Potential Elk Restoration in Minnesota

Landowner Attitudes toward Potential Elk Restoration in Minnesota



Your help on this survey is greatly appreciated!

Please return your completed questionnaire in the enclosed envelope. The envelope is self-addressed and no postage is required. Thanks!

Minnesota Cooperative Fish & Wildlife Research Unit,
1980 Folwell Ave., 200 Hodson Hall
Department of Fisheries, Wildlife, and Conservation Biology
University of Minnesota
St. Paul, MN 55108

V1

I. Your land in Minnesota

1. **First, we have a few questions about the property you own. How many total acres did you own at the end of 2017?**

   _____ Acres Owned

2. **Please indicate how much of your property within the study areas in Minnesota are in each of the following categories.** (*Please circle one number for each row below*)

Land Type	None	Some	Most	All
Private residence (house, lawns, associated buildings)	0	1	2	3
Hayfields	0	1	2	3
Livestock pasture	0	1	2	3
Row crops (corn, beans)	0	1	2	3
Small grains (wheat, oats)	0	1	2	3
Woodlands (natural forest or tree plantings)	0	1	2	3
Brushland (including abandoned, overgrown fields)	0	1	2	3
Wildlife food plots	0	1	2	3
Wetlands (including alder swamp & marsh)	0	1	2	3
Other (Please list:_____)	0	1	2	3

3. **Please indicate if you have used your land for any of the following activities in the last 5 years.** (*Select 'yes' or 'no' for each*)

Activity	Yes	No
Row crops (corn, beans)	❑	❑
Small grains (wheat, oats)	❑	❑
Hay production	❑	❑
Livestock grazing	❑	❑
Timber production	❑	❑
Maple syrup production	❑	❑
Residential use	❑	❑
Commercial/Industrial use	❑	❑
Hunting	❑	❑
Other (Please list: _____)	❑	❑

4. **Which best describes your property within the study areas in Minnesota?** (*Check all that apply*)
   - ❑ Primary residence
   - ❑ Agricultural production
   - ❑ Rental property
   - ❑ Business property
   - ❑ Seasonal or recreational residence ➡ ***If seasonal***:

     How many months of the year do you reside here?

     _____ MONTHS

     Where is your full-time residence? (*Please check one*)
     - ❑ 7-county Twin Cities metro (Hennepin, Ramsey, Dakota, Anoka, Washington, Scott, Carver)
     - ❑ Metropolitan area outside the Twin Cities (ex. St. Cloud, Duluth)
     - ❑ Rural area
     - ❑ Outside Minnesota

II. Knowledge about elk in Minnesota

5. **The remainder of the survey will address restoring wild, free-ranging elk within the 3 study areas in Minnesota. To estimate your knowledge of elk in Minnesota, please answer the following questions based on knowledge you had prior to receiving this questionnaire.** (*Please circle one number for each row below*)

	Yes	No
Did you know that wild, free-ranging elk historically lived in most of Minnesota?	1	2
Did you know that approximately 100 wild, free-ranging elk live in northwest Minnesota?	1	2
Did you know that wild, free-ranging elk have previously been restored to parts of northwest Minnesota?	1	2

III. Attitudes about elk restoration

6. **The following questions will help us determine your attitudes toward restoring wild, free-ranging elk within the study areas in Minnesota. Overall, how would you describe your feelings about potentially restoring wild, free-ranging elk within the study areas in Minnesota?** (*Please circle one number below*)

Very Unfavorable	Moderately Unfavorable	Slightly Unfavorable	Neutral	Slightly Favorable	Moderately Favorable	Very Favorable
1	2	3	4	5	6	7

7. **How important or unimportant are decisions regarding the potential restoration of wild, free-ranging elk within the study areas in Minnesota to you personally?** (*Please circle one number below*)

Very Unimportant	Moderately Unimportant	Slightly Unimportant	Neither	Slightly Important	Moderately Important	Very Important
1	2	3	4	5	6	7

8. **How unlikely or likely are you to support restoring wild, free-ranging elk…?** (*Please circle one number for each row*)

	Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
… To Minnesota in general?	1	2	3	4	5	6	7
… To the study areas in Minnesota?	1	2	3	4	5	6	7
… Within five miles of your property?	1	2	3	4	5	6	7
… On your property?	1	2	3	4	5	6	7

9. **We want to know how the idea of restoring wild, free-ranging elk within the study areas in Minnesota makes you feel. When thinking about potentially restoring elk within the study areas in Minnesota, how much do you feel…?** (*Circle one number for each row*)

	None				Moderate						A lot
Worried	0	1	2	3	4	5	6	7	8	9	10
Interested	0	1	2	3	4	5	6	7	8	9	10
Supportive	0	1	2	3	4	5	6	7	8	9	10

10. **Would you say supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is…?** (*Please circle one number for each row below*)

	Very	Quite	Slightly	Neither	Slightly	Quite	Very	
Negative	1	2	3	4	5	6	7	Positive
Harmful	1	2	3	4	5	6	7	Beneficial
Bad	1	2	3	4	5	6	7	Good

11. **Would most people who are important to you believe that you should or should not support restoring a wild, free-ranging elk population within the study areas in Minnesota?** (*Please circle one number below*)

Very much should not	Moderately should not	Slightly should not	Neither	Slightly should	Moderately should	Very much should
1	2	3	4	5	6	7

12. **Do you disagree or agree that you want to do what people who are important to you think you should do regarding supporting the restoration of wild, free-ranging elk population within the study areas in Minnesota?** (*Please circle one number below*)

Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither	Slightly Agree	Moderately Agree	Strongly Agree
1	2	3	4	5	6	7

13. **How <u>unlikely or likely</u> do you believe the following potential outcomes are from restoring a wild, free-ranging elk population within the study areas in Minnesota…?** (*Please circle one number for each row below*)

	Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
Increase youth involvement and interest in outdoors	1	2	3	4	5	6	7
Restore a native wildlife species	1	2	3	4	5	6	7
Increase economic opportunities through elk-related tourism	1	2	3	4	5	6	7
Provide opportunities to hunt elk	1	2	3	4	5	6	7
Increase damage to agriculture and personal property	1	2	3	4	5	6	7
Shift management focus from other wildlife species such as deer and moose	1	2	3	4	5	6	7
Conflict between elk and deer	1	2	3	4	5	6	7
Conflict between elk and moose	1	2	3	4	5	6	7
Negatively impact other wildlife populations	1	2	3	4	5	6	7
Increase conflict among people due to elk	1	2	3	4	5	6	7
Increase damage to trees and forest vegetation	1	2	3	4	5	6	7
Increase risk of disease transmission to livestock and wildlife	1	2	3	4	5	6	7
Increase cost to taxpayers	1	2	3	4	5	6	7
Provide opportunities to view elk	1	2	3	4	5	6	7

14. **How <u>bad or good</u> do you believe the following potential outcomes are from restoring a wild, free-ranging elk population within the study areas in Minnesota…?** (*Please circle one number for each row below*)

	Very Bad	Quite Bad	Slightly Bad	Neutral	Slightly Good	Quite Good	Very Good
Increase youth involvement and interest in outdoors	1	2	3	4	5	6	7
Restore a native wildlife species	1	2	3	4	5	6	7
Increase economic opportunities through elk-related tourism	1	2	3	4	5	6	7
Provide opportunities to hunt elk	1	2	3	4	5	6	7
Increase damage to agriculture and personal property	1	2	3	4	5	6	7
Shift management focus from other wildlife species such as deer and moose	1	2	3	4	5	6	7
Conflict between elk and deer	1	2	3	4	5	6	7
Conflict between elk and moose	1	2	3	4	5	6	7
Negatively impact other wildlife populations	1	2	3	4	5	6	7
Increase conflict among people due to elk	1	2	3	4	5	6	7
Increase damage to trees and forest vegetation	1	2	3	4	5	6	7
Increase risk of disease transmission to livestock and wildlife	1	2	3	4	5	6	7
Increase cost to taxpayers	1	2	3	4	5	6	7
Provide opportunities to view elk	1	2	3	4	5	6	7

15. **How <u>unlikely or likely</u> is it that the people/groups listed below think you <u>should</u> support restoring a wild, free-ranging elk population within the study areas in Minnesota?** (*Please circle one number for each row below*)

	Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
Most of my family and friends	1	2	3	4	5	6	7
Most hunters I know	1	2	3	4	5	6	7
Most local hunting organizations	1	2	3	4	5	6	7
Most local government officials	1	2	3	4	5	6	7
Most local landowners	1	2	3	4	5	6	7
Minnesota DNR	1	2	3	4	5	6	7
Local farmers & livestock producers	1	2	3	4	5	6	7
Most local residents	1	2	3	4	5	6	7
Most of my neighbors	1	2	3	4	5	6	7
Local conservation/environmental organizations	1	2	3	4	5	6	7
Local timber industry	1	2	3	4	5	6	7
Local agricultural groups	1	2	3	4	5	6	7

16. **Next we would like to know how likely you are to do what those people and groups would want you to do regarding a wild, free-ranging elk population within the study areas in Minnesota. How unlikely or likely are you to do what the following people/groups want you to do concerning supporting the restoration of an elk population within the study areas in Minnesota?** (*Please circle one number for each row below*)

	Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
Most of my family and friends	1	2	3	4	5	6	7
Most hunters I know	1	2	3	4	5	6	7
Most local hunting organizations	1	2	3	4	5	6	7
Most local government officials	1	2	3	4	5	6	7
Most local landowners	1	2	3	4	5	6	7
The Minnesota DNR	1	2	3	4	5	6	7
Local farmers & livestock producers	1	2	3	4	5	6	7
Most local residents	1	2	3	4	5	6	7
Most of my neighbors	1	2	3	4	5	6	7
Local conservation/environmental organizations	1	2	3	4	5	6	7
Local timber industry	1	2	3	4	5	6	7
Local agricultural groups	1	2	3	4	5	6	7

IV. Importance of Issues Related to Elk Restoration

17. **The following questions will help managers better understand what you believe are the most important issues when considering whether wild, free-ranging elk should be restored within the study areas in Minnesota. There are a variety of issues to consider in making decisions about restoration of an elk population. You will be presented with 8 scenarios that include 5 hypothetical objectives to consider related to elk restoration. For each scenario, please check one box for the objective you consider most important and one box for the objective you consider least important.**

Scenario 1. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Minimize costs of government elk management activities	❑
❑	Restoration of a native species	❑
❑	Minimize damage to trees and forest vegetation	❑
❑	Maximize economic opportunities through elk-related tourism and recreation	❑
❑	Minimize damage to agriculture and personal property (e.g., fences, vehicles)	❑

Scenario 2. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Minimize damage to trees and forest vegetation	❑
❑	Minimize costs of government elk management activities	❑
❑	Provide elk viewing opportunities	❑
❑	Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	❑
❑	Minimize impacts to deer populations and deer hunting	❑

Scenario 3. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	❑
❑	Minimize damage to agriculture and personal property (e.g., fences, vehicles)	❑
❑	Minimize costs of government elk management activities	❑
❑	Provide elk viewing opportunities	❑
❑	Provide elk hunting opportunities	❑

Scenario 4. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Provide elk viewing opportunities	❑
❑	Provide elk hunting opportunities	❑
❑	Minimize impacts to deer populations and deer hunting	❑
❑	Minimize damage to agriculture and personal property (e.g., fences, vehicles)	❑
❑	Maximize economic opportunities through elk-related tourism and recreation	❑

Scenario 5. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Provide elk hunting opportunities	❑
❑	Minimize impacts to deer populations and deer hunting	❑
❑	Minimize damage to agriculture and personal property (e.g., fences, vehicles)	❑
❑	Minimize damage to trees and forest vegetation	❑
❑	Maximum sustainable elk population size	❑

Scenario 6. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Restoration of a native species	❑
❑	Maximize economic opportunities through elk-related tourism and recreation	❑
❑	Maximum sustainable elk population size	❑
❑	Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	❑
❑	Provide elk viewing opportunities	❑

Scenario 7. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Maximum sustainable elk population size	❑
❑	Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	❑
❑	Restoration of a native species	❑
❑	Minimize costs of government elk management activities	❑
❑	Provide elk hunting opportunities	❑

Scenario 8. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Maximize economic opportunities through elk-related tourism and recreation	❑
❑	Minimize damage to trees and forest vegetation	❑
❑	Maximum sustainable elk population size	❑
❑	Restoration of a native species	❑
❑	Minimize impacts to deer populations and deer hunting	❑

V. Risks of restoring elk

18. **The following questions will help us understand your perceptions of the potential risks from restoring wild, free-ranging elk within the study areas in Minnesota. In general, how severe are the potential risks of restoring wild, free-ranging elk within the study areas in Minnesota***? (Please circle one number below where 1 = No Risk, 4 = Moderate Risk and 7 = Extreme Risk)*

No Risk 1 2 3 4 5 6 7 Extreme Risk

19. **In general, how great are the potential benefits of restoring wild, free-ranging elk within the study areas in Minnesota?** *(Please circle one number below where 1 = No Benefit, 4 = Moderate Benefit and 7 = Extreme Benefit)*

No Benefit 1 2 3 4 5 6 7 Extreme Benefit

20. **How certain are you about potential risks and benefits of restoring wild, free-ranging elk within the study areas in Minnesota?** *(Please circle one number below where 1 = Very Uncertain and 7 = Very Certain)*

Very Uncertain 1 2 3 4 5 6 7 Very Certain

21. **If wild, free-ranging elk are restored within the study areas in Minnesota, how much personal control do you believe you would have to limit risk to yourself?** *(Please circle one number below where 1 = No Control, 4 = Moderate Control and 7 = Complete Control)*

No Control 1 2 3 4 5 6 7 Complete Control

VI. Impacts of deer and elk

22. **The following questions will help us understand your perceptions of the potential impacts of restoring a wild, free-ranging elk population within the study areas in Minnesota compared to the current impacts of deer. Currently, how much of a threat do you think <u>DEER</u> within the study areas pose to…?** (*Please circle one number for each row below*)

	No Threat			Moderate Threat			Extreme Threat
… Your own economic well-being (agriculture, personal property)?	1	2	3	4	5	6	7
… Your own health/safety (vehicle collisions, etc.)?	1	2	3	4	5	6	7
… The economic well-being of individuals in the local community (agriculture, personal property)?	1	2	3	4	5	6	7
… The health/safety of individuals in the local community (vehicle collisions, etc.)?	1	2	3	4	5	6	7
… Other wildlife in area (disease, etc.)?	1	2	3	4	5	6	7
… Trees and forest vegetation?	1	2	3	4	5	6	7

23. **If elk were restored, how much threat do you think having <u>ELK</u> within the study areas would pose to…?** (*Please circle one number for each row below*)

	No Threat			Moderate Threat			Extreme Threat
… Your own economic well-being (agriculture, personal property)?	1	2	3	4	5	6	7
… Your own health/safety (vehicle collisions, etc.)?	1	2	3	4	5	6	7
… The economic well-being of individuals in the local community (agriculture, personal property)?	1	2	3	4	5	6	7
… The health/safety of individuals in the local community (vehicle collisions, etc.)?	1	2	3	4	5	6	7
… Other wildlife in area (disease, etc.)?	1	2	3	4	5	6	7
… Trees and forest vegetation?	1	2	3	4	5	6	7

24. **If wild, free-ranging elk are restored within the study areas in Minnesota, how much personal control do you believe you would have to…?** (*Please circle one number for each row below*)

	No Control			Moderate Control			Complete Control
… Limit elk damage to your agricultural and personal property?	1	2	3	4	5	6	7
… Limit elk damage to your trees and forest vegetation?	1	2	3	4	5	6	7
… Limit impact of elk to deer and other wildlife in the study areas?	1	2	3	4	5	6	7
… Influence elk management decisions in study areas?	1	2	3	4	5	6	7

VII. Importance of Elk in Minnesota

25. **Please identify if you disagree or agree with each of the following statements.** (*Circle one number for each row*)

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither	Slightly Agree	Moderately Agree	Strongly Agree
It is important that Minnesota someday have an abundant elk population within the study areas.	1	2	3	4	5	6	7
Whether or not I would get to see an elk, it is important to me that they could exist within the study areas.	1	2	3	4	5	6	7
It is important to establish elk populations within the study areas so future generations can enjoy them.	1	2	3	4	5	6	7

VIII. Trust in wildlife managers

26. **Please let us know whether you disagree or agree with the following statements about wildlife management within the study areas in Minnesota if elk are restored to the study areas.** (*Circle one number for each row*)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
When deciding about elk management, wildlife managers would be open and honest in the things they do and say.	1	2	3	4	5
Wildlife managers can be trusted to make decisions about elk management that are good for the resource.	1	2	3	4	5
Wildlife managers will make decisions about elk management in a way that is fair.	1	2	3	4	5

IX. Elk-related recreation

27. **The next questions will help us understand your experience with elk and elk-related recreation. If a wild, free-ranging elk population is restored within the study areas in Minnesota, how likely or unlikely would you be to make a trip for which viewing, photographing or hearing elk is an important part of the trip?** (*Please circle one number below*)

Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
1	2	3	4	5	6	7

28. **Have you ever visited a National Park or similar destination in North America for which an important part of the trip was viewing, photographing or hearing elk?** (*Please check yes or no*)
    - ❑ Yes
    - ❑ No

29. **Have you ever lived in an area where elk were common?** (*Please check yes or no*)
    - ❑ Yes
    - ❑ No

30. **Have you hunted elk or applied for an elk license in Minnesota or elsewhere in North America?** (*Check all that apply*)

- ❑ I have applied for or have drawn a Minnesota elk license.
- ❑ I plan to apply for a Minnesota elk license in the future.
- ❑ I do not plan to apply for a Minnesota elk license in the future.
- ❑ I have hunted elk or applied to hunt elk elsewhere in North America.

X. Outdoor activities and membership

31. **In which of the following activities have you participated in the last 12 months?** (*Check all that apply*)

- ❑ Deer hunting
- ❑ Other hunting or trapping
- ❑ Wildlife watching or photography
- ❑ Feeding wildlife
- ❑ Snowmobiling
- ❑ ATV riding
- ❑ Hiking
- ❑ Fishing
- ❑ RV or tent camping
- ❑ Cross-country skiing
- ❑ None of the above
- ❑ Other (please specify): _____

32. **Are you currently a member of:** (*Check <u>all</u> that apply*)

- ❑ Rocky Mountain Elk Foundation
- ❑ Minnesota Deer Hunters Association
- ❑ Quality Deer Management Association
- ❑ Other environmental/conservation/hunting organization(s): *Please specify*: _____
- ❑ Local sporting club
- ❑ Sierra Club
- ❑ The Nature Conservancy
- ❑ National Audubon Society

XI. The last questions will help us know more about you.

33. **Which best describes the primary area where you were raised as a youth?** (*Check one*)

- ❑ Rural on a farm
- ❑ Rural non-farm
- ❑ Small town
- ❑ Suburb
- ❑ City

34. **Which of the following best represents your gross household income (before taxes) last year?** (*Check one*)

- ❑ Less than $10,000
- ❑ $10,000 to $19,999
- ❑ $20,000 to $29,999
- ❑ $30,000 to $39,999
- ❑ $40,000 to $49,999
- ❑ $50,000 to $59,999
- ❑ $60,000 to $69,999
- ❑ $70,000 to $79,999
- ❑ $80,000 to $89,999
- ❑ $90,000 to $99,999
- ❑ $100,000 to $124,999
- ❑ $125,000 to $149,999
- ❑ $150,000 to $174,999
- ❑ $175,000 to $199,999
- ❑ $200,000 or more

35. **What percent of your total household income is derived from agricultural activities?** (*Please check one*)

- ❑ None
- ❑ 1-25%
- ❑ 26-50%
- ❑ 51-75%
- ❑ 76-100%

36. **What is the highest level of education you have completed?** (*Check one*)

- ❑ Grade school
- ❑ Some high school
- ❑ High school diploma or GED
- ❑ Some vocational or technical school
- ❑ Vocational or technical school (associate's) degree
- ❑ Some college
- ❑ Four-year college (bachelor's) degree
- ❑ Some graduate school
- ❑ Graduate (master's or doctoral) degree

37. **How many years have you lived in Minnesota?** _____ Years

38. **How many years have you owned this property within the study areas in Minnesota?** _____ Years

39. **What is your gender?** ❑ Male ❑ Female ❑ Other / rather not identify

40. **What is your age?** _____ Years old

Thank you for your participation!

❑ Check this box if you would like us to email you when the results of the survey are posted online. Please provide your email address below.

E-mail: _____

❑ Check this box if you would be willing to allow University of Minnesota researchers to measure woody and non-woody plants on your property in summer 2018. We would like to estimate potential elk forage available on public and private land within the study areas in Minnesota. This process typically takes less than one day. Please provide your email address or phone number below.

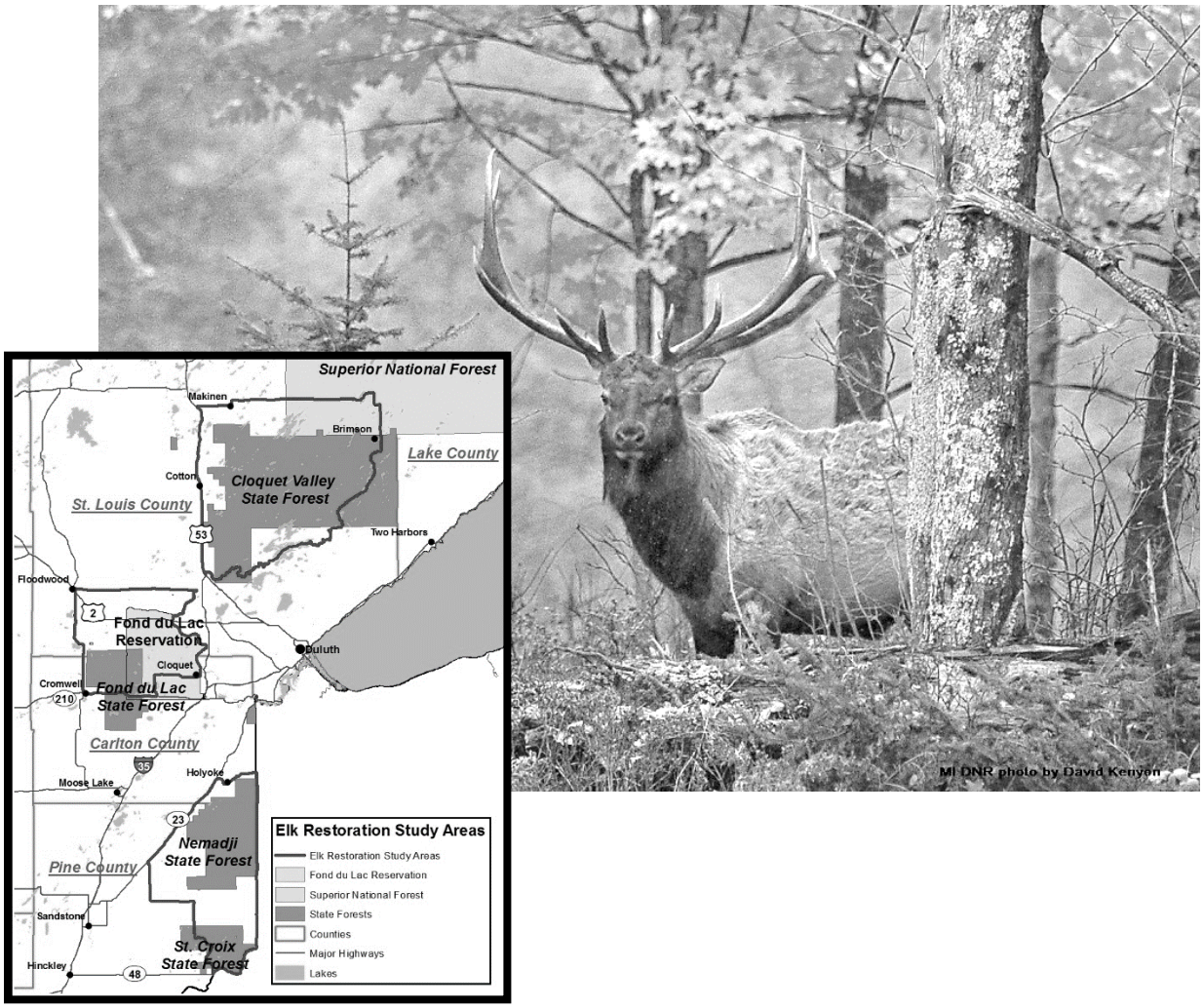
Phone: _____

E-mail: _____

Please write any comments you may have in the space below (feel free to include a separate page):

Appendix B:
Public Attitudes toward Potential Elk Restoration in Minnesota

Public Attitudes toward Potential Elk Restoration in Minnesota



Your help on this survey is greatly appreciated!

Please return your completed questionnaire in the enclosed envelope. The envelope is self-addressed and no postage is required. Thanks!

Minnesota Cooperative Fish & Wildlife Research Unit,
1980 Folwell Ave., 200 Hodson Hall
Department of Fisheries, Wildlife, and Conservation Biology
University of Minnesota
St. Paul, MN 55108

V1

I. Knowledge about elk in Minnesota

1. **This survey will address restoring wild, free-ranging elk within the 3 study areas in Minnesota. To estimate your knowledge of elk in Minnesota, please answer the following questions based on knowledge you had prior to receiving this questionnaire.** (*Please circle one number for each row below*)

	Yes	No
Did you know that wild, free-ranging elk historically lived in most of Minnesota?	1	2
Did you know that approximately 100 wild, free-ranging elk live in northwest Minnesota?	1	2
Did you know that wild, free-ranging elk have previously been restored to parts of northwest Minnesota?	1	2

II. Attitudes about elk restoration

2. **The following questions will help us determine your attitudes toward restoring wild, free-ranging elk within the study areas in Minnesota. Overall, how would you describe your feelings about potentially restoring wild, free-ranging elk within the study areas in Minnesota?** (*Please circle one number below*)

Very Unfavorable	Moderately Unfavorable	Slightly Unfavorable	Neutral	Slightly Favorable	Moderately Favorable	Very Favorable
1	2	3	4	5	6	7

3. **How important or unimportant are decisions regarding the potential restoration of wild, free-ranging elk within the study areas in Minnesota to you personally?** (*Please circle one number below*)

Very Unimportant	Moderately Unimportant	Slightly Unimportant	Neither	Slightly Important	Moderately Important	Very Important
1	2	3	4	5	6	7

4. **How unlikely or likely are you to support restoring wild, free-ranging elk…?** (*Please circle one number for each row*)

	Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
… To Minnesota in general?	1	2	3	4	5	6	7
… To the study areas in Minnesota?	1	2	3	4	5	6	7

5. **We want to know how the idea of restoring wild, free-ranging elk within the study areas in Minnesota makes you feel. When thinking about potentially restoring elk within the study areas in Minnesota, how much do you feel…?** (*Circle one number for each row*)

	None					Moderate					A lot
Worried	0	1	2	3	4	5	6	7	8	9	10
Interested	0	1	2	3	4	5	6	7	8	9	10
Supportive	0	1	2	3	4	5	6	7	8	9	10

6. **Would you say supporting the restoration of a wild, free-ranging elk population within the study areas in Minnesota is…?** (*Please circle one number for each row below*)

	Very	Quite	Slightly	Neither	Slightly	Quite	Very	
Negative	1	2	3	4	5	6	7	Positive
Harmful	1	2	3	4	5	6	7	Beneficial
Bad	1	2	3	4	5	6	7	Good

7. **Would most people who are important to you believe that you should or should not support restoring a wild, free-ranging elk population within the study areas in Minnesota?** (*Please circle one number below*)

Very much should not	Moderately should not	Slightly should not	Neither	Slightly should	Moderately should	Very much should
1	2	3	4	5	6	7

8. **Do you disagree or agree that you want to do what people who are important to you think you should do regarding supporting the restoration of wild, free-ranging elk population within the study areas in Minnesota?** (*Please circle one number below*)

Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither	Slightly Agree	Moderately Agree	Strongly Agree
1	2	3	4	5	6	7

9. **How <u>unlikely or likely</u> do you believe the following potential outcomes are from restoring a wild, free-ranging elk population within the study areas in Minnesota…?** (*Please circle one number for each row below*)

	Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
Increase youth involvement and interest in outdoors	1	2	3	4	5	6	7
Restore a native wildlife species	1	2	3	4	5	6	7
Increase economic opportunities through elk-related tourism	1	2	3	4	5	6	7
Provide opportunities to hunt elk	1	2	3	4	5	6	7
Increase damage to agriculture and personal property	1	2	3	4	5	6	7
Shift management focus from other wildlife species such as deer and moose	1	2	3	4	5	6	7
Conflict between elk and deer	1	2	3	4	5	6	7
Conflict between elk and moose	1	2	3	4	5	6	7
Negatively impact other wildlife populations	1	2	3	4	5	6	7
Increase conflict among people due to elk	1	2	3	4	5	6	7
Increase damage to trees and forest vegetation	1	2	3	4	5	6	7
Increase risk of disease transmission to livestock and wildlife	1	2	3	4	5	6	7
Increase cost to taxpayers	1	2	3	4	5	6	7
Provide opportunities to view elk	1	2	3	4	5	6	7

10. **How <u>bad or good</u> do you believe the following potential outcomes are from restoring a wild, free-ranging elk population within the study areas in Minnesota…?** (*Please circle one number for each row below*)

	Very Bad	Quite Bad	Slightly Bad	Neutral	Slightly Good	Quite Good	Very Good
Increase youth involvement and interest in outdoors	1	2	3	4	5	6	7
Restore a native wildlife species	1	2	3	4	5	6	7
Increase economic opportunities through elk-related tourism	1	2	3	4	5	6	7
Provide opportunities to hunt elk	1	2	3	4	5	6	7
Increase damage to agriculture and personal property	1	2	3	4	5	6	7
Shift management focus from other wildlife species such as deer and moose	1	2	3	4	5	6	7
Conflict between elk and deer	1	2	3	4	5	6	7
Conflict between elk and moose	1	2	3	4	5	6	7
Negatively impact other wildlife populations	1	2	3	4	5	6	7
Increase conflict among people due to elk	1	2	3	4	5	6	7
Increase damage to trees and forest vegetation	1	2	3	4	5	6	7
Increase risk of disease transmission to livestock and wildlife	1	2	3	4	5	6	7
Increase cost to taxpayers	1	2	3	4	5	6	7
Provide opportunities to view elk	1	2	3	4	5	6	7

11. **How <u>unlikely or likely</u> is it that the people/groups listed below think you <u>should</u> support restoring a wild, free-ranging elk population within the study areas in Minnesota?** (*Please circle one number for each row below*)

	Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
Most of my family and friends	1	2	3	4	5	6	7
Most hunters I know	1	2	3	4	5	6	7
Most local hunting organizations	1	2	3	4	5	6	7
Most local government officials	1	2	3	4	5	6	7
Most local landowners	1	2	3	4	5	6	7
Minnesota DNR	1	2	3	4	5	6	7
Local farmers & livestock producers	1	2	3	4	5	6	7
Most local residents	1	2	3	4	5	6	7
Most of my neighbors	1	2	3	4	5	6	7
Local conservation/environmental organizations	1	2	3	4	5	6	7
Local timber industry	1	2	3	4	5	6	7
Local agricultural groups	1	2	3	4	5	6	7

12. **Next we would like to know how likely you are to do what those people and groups would want you to do regarding a wild, free-ranging elk population within the study areas in Minnesota. How unlikely or likely are you to do what the following people/groups want you to do concerning supporting the restoration of an elk population within the study areas in Minnesota?** (*Please circle one number for each row below*)

	Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
Most of my family and friends	1	2	3	4	5	6	7
Most hunters I know	1	2	3	4	5	6	7
Most local hunting organizations	1	2	3	4	5	6	7
Most local government officials	1	2	3	4	5	6	7
Most local landowners	1	2	3	4	5	6	7
The Minnesota DNR	1	2	3	4	5	6	7
Local farmers & livestock producers	1	2	3	4	5	6	7
Most local residents	1	2	3	4	5	6	7
Most of my neighbors	1	2	3	4	5	6	7
Local conservation/environmental organizations	1	2	3	4	5	6	7
Local timber industry	1	2	3	4	5	6	7
Local agricultural groups	1	2	3	4	5	6	7

III. Importance of Issues Related to Elk Restoration

13. **The following questions will help managers better understand what you believe are the most important issues when considering whether wild, free-ranging elk should be restored within the study areas in Minnesota. There are a variety of issues to consider in making decisions about restoration of an elk population. You will be presented with 8 scenarios that include 5 hypothetical objectives to consider related to elk restoration. For each scenario, please check one box for the objective you consider most important and one box for the objective you consider least important.**

Scenario 1. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Minimize costs of government elk management activities	❑
❑	Restoration of a native species	❑
❑	Minimize damage to trees and forest vegetation	❑
❑	Maximize economic opportunities through elk-related tourism and recreation	❑
❑	Minimize damage to agriculture and personal property (e.g., fences, vehicles)	❑

Scenario 2. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Minimize damage to trees and forest vegetation	❑
❑	Minimize costs of government elk management activities	❑
❑	Provide elk viewing opportunities	❑
❑	Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	❑
❑	Minimize impacts to deer populations and deer hunting	❑

Scenario 3. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	❑
❑	Minimize damage to agriculture and personal property (e.g., fences, vehicles)	❑
❑	Minimize costs of government elk management activities	❑
❑	Provide elk viewing opportunities	❑
❑	Provide elk hunting opportunities	❑

Scenario 4. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Provide elk viewing opportunities	❑
❑	Provide elk hunting opportunities	❑
❑	Minimize impacts to deer populations and deer hunting	❑
❑	Minimize damage to agriculture and personal property (e.g., fences, vehicles)	❑
❑	Maximize economic opportunities through elk-related tourism and recreation	❑

Scenario 5. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Provide elk hunting opportunities	❑
❑	Minimize impacts to deer populations and deer hunting	❑
❑	Minimize damage to agriculture and personal property (e.g., fences, vehicles)	❑
❑	Minimize damage to trees and forest vegetation	❑
❑	Maximum sustainable elk population size	❑

Scenario 6. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Restoration of a native species	❑
❑	Maximize economic opportunities through elk-related tourism and recreation	❑
❑	Maximum sustainable elk population size	❑
❑	Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	❑
❑	Provide elk viewing opportunities	❑

Scenario 7. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Maximum sustainable elk population size	❑
❑	Minimize impacts to existing wildlife populations (e.g., disease, resource competition)	❑
❑	Restoration of a native species	❑
❑	Minimize costs of government elk management activities	❑
❑	Provide elk hunting opportunities	❑

Scenario 8. Please check the one objective you think is most important and the one objective that is least important.

Most Important	Objectives	Least Important
❑	Maximize economic opportunities through elk-related tourism and recreation	❑
❑	Minimize damage to trees and forest vegetation	❑
❑	Maximum sustainable elk population size	❑
❑	Restoration of a native species	❑
❑	Minimize impacts to deer populations and deer hunting	❑

IV. Risks of restoring elk

14. **The following questions will help us understand your perceptions of the potential risks from restoring wild, free-ranging elk within the study areas in Minnesota. In general, how severe are the potential risks of restoring wild, free-ranging elk within the study areas in Minnesota***? (Please circle one number below where 1 = No Risk, 4 = Moderate Risk and 7 = Extreme Risk)*

No Risk 1 2 3 4 5 6 7 Extreme Risk

15. **In general, how great are the potential benefits of restoring wild, free-ranging elk within the study areas in Minnesota?** *(Please circle one number below where 1 = No Benefit, 4 = Moderate Benefit and 7 = Extreme Benefit)*

No Benefit 1 2 3 4 5 6 7 Extreme Benefit

16. **How certain are you about potential risks and benefits of restoring wild, free-ranging elk within the study areas in Minnesota?** *(Please circle one number below where 1 = Very Uncertain and 7 = Very Certain)*

Very Uncertain 1 2 3 4 5 6 7 Very Certain

17. **If wild, free-ranging elk are restored within the study areas in Minnesota, how much personal control do you believe you would have to limit risk to yourself?** *(Please circle one number below where 1 = No Control, 4 = Moderate Control and 7 = Complete Control)*

No Control 1 2 3 4 5 6 7 Complete Control

V. Impacts of deer and elk

18. **The following questions will help us understand your perceptions of the potential impacts of restoring a wild, free-ranging elk population within the study areas in Minnesota compared to the current impacts of deer. Currently, how much of a threat do you think <u>DEER</u> within the study areas pose to…?** (*Please circle one number for each row below*)

	No Threat			Moderate Threat			Extreme Threat
… Your own economic well-being (agriculture, personal property)?	1	2	3	4	5	6	7
… Your own health/safety (vehicle collisions, etc.)?	1	2	3	4	5	6	7
… The economic well-being of individuals in the local community (agriculture, personal property)?	1	2	3	4	5	6	7
… The health/safety of individuals in the local community (vehicle collisions, etc.)?	1	2	3	4	5	6	7
… Other wildlife in area (disease, etc.)?	1	2	3	4	5	6	7
… Trees and forest vegetation?	1	2	3	4	5	6	7

19. **If elk were restored, how much threat do you think having <u>ELK</u> within the study areas would pose to…?** (*Please circle one number for each row below*)

	No Threat			Moderate Threat			Extreme Threat
… Your own economic well-being (agriculture, personal property)?	1	2	3	4	5	6	7
… Your own health/safety (vehicle collisions, etc.)?	1	2	3	4	5	6	7
… The economic well-being of individuals in the local community (agriculture, personal property)?	1	2	3	4	5	6	7
… The health/safety of individuals in the local community (vehicle collisions, etc.)?	1	2	3	4	5	6	7
… Other wildlife in area (disease, etc.)?	1	2	3	4	5	6	7
… Trees and forest vegetation?	1	2	3	4	5	6	7

20. **If wild, free-ranging elk are restored within the study areas in Minnesota, how much personal control do you believe you would have to influence elk management decisions in study areas?** (*(Please circle one number below where 1 = No Control, 4 = Moderate Control and 7 = Complete Control*)

No Control 1 2 3 4 5 6 7 Complete Control

VI. Importance of Elk in Minnesota

21. **Please identify if you disagree or agree with each of the following statements.** (*Circle one number for each row*)

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither	Slightly Agree	Moderately Agree	Strongly Agree
It is important that Minnesota someday have an abundant elk population within the study areas.	1	2	3	4	5	6	7
Whether or not I would get to see an elk, it is important to me that they could exist within the study areas.	1	2	3	4	5	6	7
It is important to establish elk populations within the study areas so future generations can enjoy them.	1	2	3	4	5	6	7

VII. Trust in elk managers

22. **Please let us know whether you disagree or agree with the following statements about wildlife management within the study areas in Minnesota if elk are restored to the study areas.** (*Circle one number for each row*)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
When deciding about elk management, wildlife managers would be open and honest in the things they do and say.	1	2	3	4	5
Wildlife managers can be trusted to make decisions about elk management that are good for the resource.	1	2	3	4	5
Wildlife managers will make decisions about elk management in a way that is fair.	1	2	3	4	5

VIII. Elk-related recreation

23. **The next questions will help us understand your experience with elk and elk-related recreation. If a wild, free-ranging elk population is restored within the study areas in Minnesota, how likely or unlikely would you be to make a trip for which viewing, photographing or hearing elk is an important part of the trip?** (*Please circle one number below*)

Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
1	2	3	4	5	6	7

24. **Have you ever visited a National Park or similar destination in North America for which an important part of the trip was viewing, photographing or hearing elk?** *(Please check yes or no)*
    - ❑ Yes
    - ❑ No

25. **Have you ever lived in an area where elk were common?** *(Please check yes or no)*
    - ❑ Yes
    - ❑ No

26. **Have you hunted elk or applied for an elk license in Minnesota or elsewhere in North America?** (*Check all that apply*)
- ❑ I have applied for or have drawn a Minnesota elk license.
- ❑ I plan to apply for a Minnesota elk license in the future.
- ❑ I do not plan to apply for a Minnesota elk license in the future.
- ❑ I have hunted elk or applied to hunt elk elsewhere in North America.

IX. Outdoor activities and membership

27. **In which of the following activities have you participated in the last 12 months?** (*Check all that apply*)
- ❑ Deer hunting
- ❑ Other hunting or trapping
- ❑ Wildlife watching or photography
- ❑ Feeding wildlife
- ❑ Snowmobiling
- ❑ ATV riding
- ❑ Hiking
- ❑ Fishing
- ❑ RV or tent camping
- ❑ Cross-country skiing
- ❑ None of the above
- ❑ Other (please specify): _____

28. **Are you currently a member of:** (*Check <u>all</u> that apply*)
- ❑ Rocky Mountain Elk Foundation
- ❑ Minnesota Deer Hunters Association
- ❑ Quality Deer Management Association
- ❑ Other environmental/conservation/hunting organization(s): *Please specify*: _____
- ❑ Local sporting club
- ❑ Sierra Club
- ❑ The Nature Conservancy
- ❑ National Audubon Society

X. The last questions will help us know more about you.

29. **Which best describes the primary area where you were raised as a youth?** (*Check one*)
- ❑ Rural on a farm
- ❑ Rural non-farm
- ❑ Small town
- ❑ Suburb
- ❑ City

30. **Which of the following best represents your gross household income (before taxes) last year?** (*Check one*)
- ❑ Less than $10,000
- ❑ $10,000 to $19,999
- ❑ $20,000 to $29,999
- ❑ $30,000 to $39,999
- ❑ $40,000 to $49,999
- ❑ $50,000 to $59,999
- ❑ $60,000 to $69,999
- ❑ $70,000 to $79,999
- ❑ $80,000 to $89,999
- ❑ $90,000 to $99,999
- ❑ $100,000 to $124,999
- ❑ $125,000 to $149,999
- ❑ $150,000 to $174,999
- ❑ $175,000 to $199,999
- ❑ $200,000 or more

31. **What is the highest level of education you have completed?** (*Check one*)
- ❑ Grade school
- ❑ Some high school
- ❑ High school diploma or GED
- ❑ Some vocational or technical school
- ❑ Vocational or technical school (associate's) degree
- ❑ Some college
- ❑ Four-year college (bachelor's) degree
- ❑ Some graduate school
- ❑ Graduate (master's or doctoral) degree

32. **How many years have you lived in Minnesota?** _____ Years

33. **Do you own or rent your current residence?** ❑ Own ❑ Rent

34. **How many years have you owned/rented your current residence?** _____ Years

35. **What is your gender?** ❑ Male ❑ Female ❑ Other / rather not identify

36. **What is your age?** _____ Years old

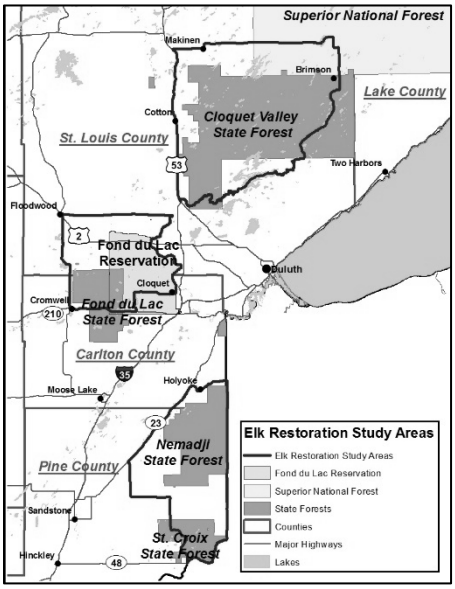
Thank you for your participation!

❑ Check this box if you would like us to email you when the results of the survey are posted online. Please provide your email address below.

E-mail: _____

Appendix C:
Shortened Survey of Landowners to Gauge Nonresponse Bias

Landowner Attitudes toward Potential Elk Restoration in Minnesota



Dear Landowner,
During the past few months, we have sent you several survey mailings. We are sending you this shortened survey because we are concerned that people who have not responded may differ from those who have already responded. We appreciate your willingness to complete this short survey as we conclude this effort to better understand issues related to potentially restoring elk to Minnesota. If you have questions or comments about this study, please contact Eric Walberg at **walbe032@umn.edu** or **612-625-3718 Ext. 1**.

Sincerely,

David Fulton, Ph.D., Adj. Professor

1. Why did you not respond to our earlier survey mailings? (*Please check all that apply*)
   - ❑ I am not interested in restoring elk.
   - ❑ Lack of knowledge about elk.
   - ❑ I did not have time.
   - ❑ The original survey was too long.
   - ❑ I never received the earlier mailings.
   - ❑ I misplaced my earlier mailings.
   - ❑ I intended to complete it, but did not get to it.
   - ❑ Challenge of returning postal survey.
   - ❑ I returned it.
   - ❑ The information and questions were too complicated.
   - ❑ Concerned about how the information would be used.
   - ❑ Other: _____

2. Which best describes your property within the study areas in Minnesota? (*Check all that apply*)
   - ❑ Primary residence
   - ❑ Agricultural production
   - ❑ Rental property
   - ❑ Business property
   - ❑ Seasonal or recreational residence

3. What percent of your total household income is derived from agricultural activities? (*Please check one*)
   - ❑ None
   - ❑ 1-25%
   - ❑ 26-50%
   - ❑ 51-75%
   - ❑ 76-100%

4. Overall, how would you describe your feelings about potentially restoring wild, free-ranging elk within the study areas in Minnesota? (*Please circle one number below*)

Very Unfavorable	Moderately Unfavorable	Slightly Unfavorable	Neutral	Slightly Favorable	Moderately Favorable	Very Favorable
1	2	3	4	5	6	7

5. How important or unimportant are decisions regarding the potential restoration of wild, free-ranging elk within the study areas in Minnesota to you personally? (*Please circle one number below*)

Very Unimportant	Moderately Unimportant	Slightly Unimportant	Neither	Slightly Important	Moderately Important	Very Important
1	2	3	4	5	6	7

6. How unlikely or likely are you to support restoring wild, free-ranging elk to Minnesota in general? (*Please circle one number below*)

Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
1	2	3	4	5	6	7

7. If a wild, free-ranging elk population is restored within the study areas in Minnesota, how likely or unlikely would you be to make a trip for which viewing, photographing or hearing elk is an important part of the trip? (*Please circle one number below*)

Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
1	2	3	4	5	6	7

8. Have you hunted elk or applied for an elk license in Minnesota or elsewhere in North America? (*Check all that apply*)
   - ❑ I have applied for or have drawn a Minnesota elk license.
   - ❑ I plan to apply for a Minnesota elk license in the future.
   - ❑ I do not plan to apply for a Minnesota elk license in the future.
   - ❑ I have hunted elk or applied to hunt elk elsewhere in North America.

9. How many years have you lived in Minnesota? _____ Years

10. How many years have you owned this property within the study areas in Minnesota? _____ Years

11. What is your gender? ❑ Male ❑ Female ❑ Other / rather not identify

12. What is your age? _____ Years old

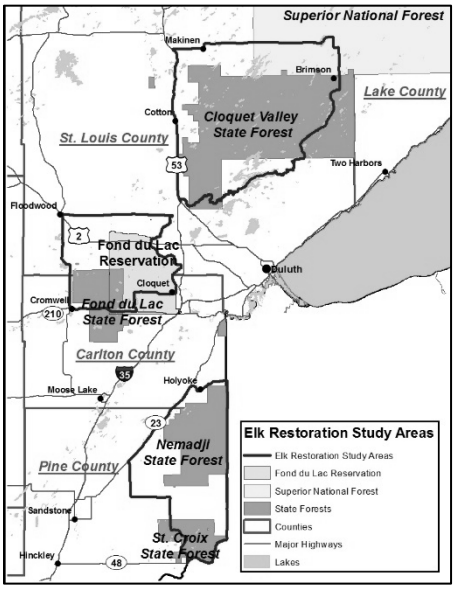
Please write any comments you may have in the space below (feel free to include a separate page).

THANK YOU FOR YOUR HELP!

Please return the completed questionnaire in the enclosed self-addressed, stamped envelope.

Appendix D:
Shortened Survey of Public to Gauge Nonresponse Bias

Public Attitudes toward Potential Elk Restoration in Minnesota



Greetings,
During the past few months, we have sent you several survey mailings. We are sending you this shortened survey because we are concerned that people who have not responded may differ from those who have already responded. We appreciate your willingness to complete this short survey as we conclude this effort to better understand issues related to potentially restoring elk to Minnesota. If you have questions or comments about this study, please contact Eric Walberg at **walbe032@umn.edu** or **612-625-3718 Ext. 1**.

Sincerely,

David Fulton, Ph.D., Adj. Professor

1. Why did you not respond to our earlier survey mailings? (*Please check all that apply*)
   - ❑ I am not interested in restoring elk.
   - ❑ Lack of knowledge about elk.
   - ❑ I did not have time.
   - ❑ The original survey was too long.
   - ❑ I never received the earlier mailings.
   - ❑ I misplaced my earlier mailings.
   - ❑ I intended to complete it, but did not get to it.
   - ❑ Challenge of returning postal survey.
   - ❑ I returned it.
   - ❑ The information and questions were too complicated.
   - ❑ Concerned about how the information would be used.
   - ❑ Other: _____

2. Overall, how would you describe your feelings about potentially restoring wild, free-ranging elk within the study areas in Minnesota? (*Please circle one number below*)

Very Unfavorable	Moderately Unfavorable	Slightly Unfavorable	Neutral	Slightly Favorable	Moderately Favorable	Very Favorable
1	2	3	4	5	6	7

3. How important or unimportant are decisions regarding the potential restoration of wild, free-ranging elk within the study areas in Minnesota to you personally? (*Please circle one number below*)

Very Unimportant	Moderately Unimportant	Slightly Unimportant	Neither	Slightly Important	Moderately Important	Very Important
1	2	3	4	5	6	7

4. How unlikely or likely are you to support restoring wild, free-ranging elk to Minnesota in general? (*Please circle one number below*)

Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
1	2	3	4	5	6	7

5. If a wild, free-ranging elk population is restored within the study areas in Minnesota, how likely or unlikely would you be to make a trip for which viewing, photographing or hearing elk is an important part of the trip? (*Please circle one number below*)

Very Unlikely	Quite Unlikely	Slightly Unlikely	Unsure	Slightly Likely	Quite Likely	Very Likely
1	2	3	4	5	6	7

6. Have you hunted elk or applied for an elk license in Minnesota or elsewhere in North America? (*Check all that apply*)
   - ❑ I have applied for or have drawn a Minnesota elk license.
   - ❑ I plan to apply for a Minnesota elk license in the future.
   - ❑ I do not plan to apply for a Minnesota elk license in the future.
   - ❑ I have hunted elk or applied to hunt elk elsewhere in North America.

7. How many years have you lived in Minnesota? _____ Years

8. What is your gender? ❑ Male ❑ Female ❑ Other / rather not identify

9. What is your age? _____ Years old

Please write any comments you may have in the space below (feel free to include a separate page).

THANK YOU FOR YOUR HELP!

Please return the completed questionnaire in the enclosed self-addressed, stamped envelope.