

## **M.L. 2013 Project Abstract**

For the Period Ending June 30, 2018

**PROJECT TITLE: Moose Habitat Restoration Techniques in Northeastern Minnesota**

**PROJECT MANAGER:** Ron Moen

**AFFILIATION:** University of Minnesota-Duluth

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**FUNDING SOURCE:** Environment and Natural Resources Trust Fund

**LEGAL CITATION:** M.L. 2013, Chp. 52, Sec. 2, Subd. 4g

**APPROPRIATION AMOUNT: \$200,000**

**AMOUNT SPENT: \$195,519**

**AMOUNT REMAINING: \$4,481**

### **Overall Project Outcome and Results**

The main outcome of this project was documenting browse species regeneration after the Ham Lake, Cavity Lake and Pagami Creek fires in the BWCA, and after forest harvest, shearing, and smaller prescribed burns. These results were used in part to inform habitat restoration decisions for an Outdoor Heritage Fund project. Differences in browse species production were similar to variation in moose range across Minnesota and across North America. About 5 species usually comprise 80% of the browse eaten in summer and in winter.

Winter and summer browsing was measured. At each site 5 transects were walked and browse species use and availability was recorded at 20 plots along each transect. We measured 176 stands covering 11,536 acres that were harvested, sheared, or burned, and 66 sites in the BWCA burns. Browse availability increased within 4 years of treatment, and leveled off within 10 years. Browse species were similar in harvested stands, sheared stands, burned stands, and the large BWCA fires. The most common browse species were hazel, aspen, and paper birch. Other species were mountain maple, willow, balsam fir, pin cherry, chokecherry, juneberry, red osier, and red maple. Mountain ash, a highly preferred browse species, was present on about 10% of stands.

Browsing intensity is affected by species composition and by moose density. All browse species were eaten, with the less common species eaten more frequently. Low browsing levels would be expected with low moose densities in Minnesota. About 2% of twigs were browsed in summer, and about 15% of twigs were browsed in winter. Regardless of whether a stand was harvested, sheared, or burned, browsing level by moose was similar. It is unlikely that browse is limiting the moose population. MN DNR projects show low moose survival rates. Adult mortalities are caused by predation and by health-related issues, calf mortalities are primarily caused by predation. If survival rates increase, browse could be more limiting.

### **Project Results Use and Dissemination**

Overall this project resulted in significant outreach to the public and to resource management agency personnel. Over the course of the project we had 71 presentations to different audiences, ranging from professional conferences, college courses, and the public. There were 5 M.S. graduate students who

were supported in part by this project and have already graduated, and 1 Ph.D. student who defended in spring 2018. Publications arising from this project include 5 M.S. theses, 1 Ph.D. thesis (not quite completed), 9 technical reports, and 9 peer-reviewed publications. There were also at least 8 different media contacts which appeared in print, on the radio, or on television.

Goal 3 identified in the work plan was to continue to involve the public, biologists, and organizations in a coordinated effort to slow or prevent a continuing decline of the NE MN moose population. This is important because of the combined research effort among biologists, agencies, and organizations. Concern about moose in Minnesota is real, and is evident in the way moose research transcends agency jurisdiction and even the international boundary. Collectively, the research project, the meetings of Minnesota moose biologists, and involvement of the public made it possible to meet this goal.



## Environment and Natural Resources Trust Fund (ENRTF) M.L. 2013 Work Plan Final Report

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**Date of Status Update Report:** November 19, 2018

**Final Report.**

**Date of Work Plan Approval:** June 11, 2013

**Project Completion Date:** June 1, 2016

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**PROJECT TITLE: Moose Habitat Restoration Techniques in Northeastern Minnesota**

**Project Manager:** Ron Moen

**Affiliation**

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**Location:** Cook, Lake, and St. Louis Counties (see map)

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**Total ENRTF Project Budget:**

**ENRTF Appropriation:** **\$200,000**

**Amount Spent:** **\$195,519**

**Balance:** **\$4,481**

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**Legal Citation:** M.L. 2013, Chp. 52, Sec. 2, Subd. 4g

**Appropriation Language:**

(g) Moose Habitat Restoration in Northeastern Minnesota

\$200,000 the first is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute to develop best practices guidelines for creating moose foraging habitat efficiently and cost-effectively. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

## I. PROJECT TITLE: Moose Habitat Restoration Techniques in Northeastern Minnesota

### II. PROJECT STATEMENT:

Research is needed to halt the decline of the moose population in Minnesota, and eventually increase the population if possible. The focus in **Identifying Critical Habitats for Moose in Northeastern Minnesota** (ML 2010, Chap. 362, Sec. 2, Subd. 3(k)) was on thermal habitat. With some of the hottest summers on record in Minnesota in recent years, thermal habitat needed to be identified and managed.

In the **Identifying Critical Habitats project** satellite GPS collars on moose collected GPS locations every 20 minutes, providing a track of where each moose went over an entire year. In addition to identifying areas used by moose when the temperature was 90° in summer, these GPS collars enabled us to find moose feeding areas and led to this proposed project. Consumption by moose was unexpectedly high in most moose feeding areas.

Identifying characteristics of feeding areas would make it possible to manage for the best possible moose foraging habitat. Initial funding from the EPA Great Lakes Restoration Initiative was obtained to restore moose habitat in Lake County and monitor moose use. A \$976K project to restore additional moose habitat in Lake, Cook, and St. Louis counties submitted by MDHA is funded through the Lessard-Sams OHF from 2012 to 2015, with an additional \$2M recommended for funding from 2013 to 2016.

Thus, 2012 marks the start of what could be a decade of intensive moose habitat management. General techniques and guidelines for creating moose habitat are known, but at present it is not known which habitat restoration methods are most cost-effective and best for moose, the topic of this **Moose Habitat Restoration Techniques** project.

**Goal 1:** Evaluate techniques for moose habitat restoration and develop best practices guidelines for creating moose foraging habitat efficiently and cost-effectively using satellite GPS collar data from moose.

Moose foraging habitat can also be created after forest fires and wind storms. Over the last 15 years forest fires and windstorms have affected almost half of the land in and near the BWCA (See map, Section IX). The Ham Lake, Cavity Lake, and Pagami Creek fires all created moose foraging habitat, and provide a unique opportunity to measure moose response to fires, monitor browse production, and determine year-round use by moose on the ground.

**Goal 2:** Determine habitat quality, current moose use, and predict future moose use of recent forest fires and the blowdown in and near the BWCA.

Results from Goal 2 also apply to Goal 1, because prescribed fire is one technique to create moose foraging habitat. Current GPS radiocollar research projects provide a great opportunity to determine best habitat management practices that should not be missed. Outcomes of this proposal will directly benefit current and future moose habitat restoration projects.

This proposal is focused on foraging habitat, with other research projects addressing different critical needs of moose. Dr. Michelle Carstensen (DNR) leads a study funded by the ENRTF to identify causes of mortality in adult moose. Dr. Glenn DelGiudice (DNR) leads a calf mortality project funded by the DNR. Some combination of managing bears, wolves, parasites, diseases, deer, humans, and habitat will be required to stabilize or reverse the moose decline.

**Goal 3:** Continue to involve the public, biologists, and organizations in a coordinated effort to slow or prevent a continuing decline of the NE MN moose population

Goal 3 is important because of the combined research effort among biologists, agencies, and organizations. Concern about moose in Minnesota is real, and is evident in the way moose research transcends agency jurisdiction and even the international boundary.

Collectively, the research projects will provide a biological basis for management decisions.

### **III. PROJECT STATUS UPDATES:**

#### **Project Status as of December 31, 2013:**

We did a pilot season of browse measurements to develop and test the technique that will be used. We also used this pilot season to collect leaves that are being analyzed for nutritional content. Overall, we completed measurements at 45 sites in ACTIVITY 1 and ACTIVITY 2. The results from each Activity are summarized in Section IV below. Briefly, we found moose browsing on at least 16 different species, and the common species were those which we expected based on past work here in Minnesota and elsewhere (quaking aspen, paper birch, beaked hazel, willow, mountain maple, and pin cherry). It was clear that older fires had more browsing pressure than the Pagami Creek fire, although the amount of browsing pressure is also partially affected by current distribution of moose in northeastern Minnesota.

We also organized the third NE MN moose research meeting on December 9-10, 2013. Attendance increased over 2012's meeting and we had to host the meeting at the Cloquet Forestry Center instead of NRRI. Glenn DelGiudice (DNR) and Ron Moen were the organizers, and over 70 tribal, DNR, university, county, and Superior National Forest biologists and managers attended. 12 of 26 presentations were by graduate students or post-doctoral scientists working with me and were directly associated with this ENRTF project, or were using locations of moose from this project. 5 presentations were about the DNR ENRTF projects, 2 presentations were about the ENRTF project for which James Forester is PI, and 1 presentation was on the Outdoor Heritage Fund moose habitat project. The remaining talks from Michigan, Ontario, and Sweden, illustrate the broader nature of the moose "problem".

#### **Project Status as of June 30, 2014:**

We did the first set of winter browse measurements in May 2014 using techniques developed in August 2013. Twigs were collected for nutritional content analysis. We completed measurements at 42 sites in ACTIVITY 1 and ACTIVITY 2. The late snowmelt reduced the amount of time that we had to complete browse measurements before leaf out, but we completed almost all browse plots. We have not yet had time to enter data collected in May 2013 and provide a summary of results.

We also continued disseminating results about this project and moose issues in general. We had several interviews on moose in Minnesota from the press, and project personnel gave 30 presentations at conferences, workshops, and universities. Highlights would be a presentation at the 2014 DNR Roundtable in Bloomington, MN and a presentation on the status of moose in Minnesota to the Environment and Natural Resources Policy Committee of the Minnesota House of Representatives on February 25, 2014.

#### **Project Status as of December 31, 2014:**

In August and September 2014 we measured summer browse at 39 sites in ACTIVITY 1 and ACTIVITY 2 using techniques developed in August 2013. Leaf samples were collected for nutritional analysis at each site. Sampling took place in late summer until leaf-drop began and twig stripping was no longer easily identifiable. As of September 2014 133 sites both inside and out of the BWCA have been sampled in Fall 2013, Spring 2014, and Fall 2014. 94 of these sites are outside of the BWCA and 39 are inside the BWCA, and they represent about 8,600 acres of burned or restored forest patches that we have sampled.

#### **Project Status as of June 30, 2015:**

Project results were presented at the MN/WI The Wildlife Society chapter meetings in Duluth, Minnesota in February 2015, and at the North American Moose Conference and Workshop in Colorado in April 2015. On April 28, 2015 Governor Dayton signed executive order 15-10, which prohibited any additional radiocollaring of

moose in Minnesota. This order does not affect work being carried out in this project as we would not be collaring any moose in the future in this project. Partially as a result of this executive order, many media contacts were made as listed below in the dissemination section.

In April and May, 2015 we measured summer browse at 46 sites in ACTIVITY 1 and ACTIVITY 2 using techniques developed in August 2013. Leaf samples were collected for nutritional analysis at each site. Sampling took place in early spring until leaf-out began and bites on twigs were no longer easily identifiable. As of June 2015, 46 sites, both inside and out of the BWCA, were measured for the spring 2015 sampling period. 36 of these sites are outside of the BWCA and 10 were adjacent or immediately within boundaries of the BWCA. The 46 sites sampled represent about 2655 acres of burned or restored forest patches across northeast Minnesota.

### **Amendment Request (08/24/2015)**

We are requesting an amendment for rebudgeting because of collaborations with other projects and some additional funds being received that will be used for this project. The reasons for rebudgeting are:

We had arranged for moose to be radiocollared this winter as part of the capture operations in the MN DNR ENRTF project (M.L. 2014, Chapter 226, Section 2, Subd. 05m Moose Decline and Air Temperatures in Northeastern Minnesota) and moose were radiocollared near Ely and Grand Marais that we can use.

The P.I. received a promotion to Associate Professor at the University of Minnesota Duluth in September 2014, which meant that he is now in a tenure track position with 9 months of salary support. Effort is shifted from him to other employees.

We underestimated the amount of travel between field sites in NE Minnesota and need to transfer funds.

We obtained other funding for some of needed supplies and need to reduce budgeted amount for supplies.

We moved \$6,000 from Activity 1 to Activity 2 in this request. There were shifts in the Personnel, Professional Services, Supplies, and Travel categories as listed in Attachment A.

### **Approved by the LCCMR 8-26-2015**

### **Project Status as of December 31, 2015:**

In August-October, 2015 summer browse was measured at an additional 53 sites by biologists at 1854 Treaty Authority and NRRRI staff. 1854 Treaty Authority biologists have taken strides to extend the project and continue collecting data to contribute to a longer term dataset that extends beyond the current project. With regard to this project, data collection wrapped up in Fall, 2015. Since Fall 2013 we have visited 232 habitat patches that could provide browse for moose and have measured attributes including stand size, browse species richness, density, and whether moose presence was observed in the form of current year feeding sign, tracks, and pellet groups. Sites were visited both within (n=61) and outside (n=171) the Boundary Waters Wilderness during springs and falls to measure use and habitat characteristics during winter and summer, respectively. Data has been entered into databases and preliminary analysis of the complete dataset has begun.

### **Amendment request 12-28-18**

More staff time was needed than planned for. We therefore request a retroactive increase in the overall personnel budget by \$8,059 (from \$164,269 to \$172,328). Funds for this increase would come from the Plant chemistry analysis professional services line, which would be reduced from \$12,000 to \$3,941. Chemical analysis was ultimately not performed during this project.

## **Overall Project Outcomes and Results:**

The main outcome of this project was documenting browse species regeneration after the Ham Lake, Cavity Lake and Pagami Creek fires in the BWCA, and after forest harvest, shearing, and smaller prescribed burns. These results were used in part to inform habitat restoration decisions for an Outdoor Heritage Fund project. Differences in browse species production were similar to variation in moose range across Minnesota and across North America. About 5 species usually comprise 80% of the browse eaten in summer and in winter.

Winter and summer browsing was measured. At each site 5 transects were walked and browse species use and availability was recorded at 20 plots along each transect. We measured 176 stands covering 11,536 acres that were harvested, sheared, or burned, and 66 sites in the BWCA burns. Browse availability increased within 4 years of treatment, and leveled off within 10 years. Browse species were similar in harvested stands, sheared stands, burned stands, and the large BWCA fires. The most common browse species were hazel, aspen, and paper birch. Other species were mountain maple, willow, balsam fir, pin cherry, chokecherry, juneberry, red osier, and red maple. Mountain ash, a highly preferred browse species, was present on about 10% of stands.

Browsing intensity is affected by species composition and by moose density. All browse species were eaten, with the less common species eaten more frequently. Low browsing levels would be expected with low moose densities in Minnesota. About 2% of twigs were browsed in summer, and about 15% of twigs were browsed in winter. Regardless of whether a stand was harvested, sheared, or burned, browsing level by moose was similar. It is unlikely that browse is limiting the moose population. MN DNR projects show low moose survival rates. Adult mortalities are caused by predation and by health-related issues, calf mortalities are primarily caused by predation. If survival rates increase, browse could be more limiting.

## **IV. PROJECT ACTIVITIES AND OUTCOMES:**

**ACTIVITY 1:** Foraging habitat restoration techniques for moose in Minnesota

### **Summary Budget Information for Activity 1:**

**ENRTF Budget: \$ 160,000**  
**Amount Spent: \$ 156,380**  
**Balance: \$ 3,620**

### **Activity Completion Date:**

<b>Outcome</b>	<b>Completion Date</b>	<b>Budget</b>
<b>1.</b> Measurement and analysis of browse production in shear, burn, and harvest areas.	1/1/2016	\$112,000
<b>2.</b> Deploy GPS collars for fine-scale foraging data on 7 moose.	1/1/2016	\$3,000
<b>3.</b> Throughout this activity work with LS-OHF habitat restoration project.	6/1/2016	\$10,000
<b>4.</b> Written report and recommendations on moose habitat restoration techniques.	6/1/2016	\$35,000

### **Activity Status as of December 31, 2013:**

We measured summer-browsing at 30 sites outside of the BWCA under this activity. 22 of these sites were harvested, 3 were burned, and 5 were sheared. At each site 5 transects were walked and browse use and availability was sampled at 20 plots along each transect. Browse presence was greater in harvested stands older

than about 10 years, but the actual pattern needs to be confirmed with additional measurements. Most browsing occurred near edges of treatment types, and if present the species that appeared to be used most were mountain maple, pin cherry, mountain ash, and paper birch, others consumed less were willow, aspen, red-osier dogwood, and red maple. Leaf samples of forage species were taken across sample sites. Summer browse species samples are currently being analyzed for nutritional content.

**Activity Status as of June 30, 2014:**

Over winter browse assessment was done before leaf-out in May, 2014 at 30 sites outside of the BWCA under this activity. 27 of these sites were harvested and 3 were sheared. At each site 5 transects were walked and browse use and availability was sampled at 20 plots along each transect. Browse presence was greater in harvested stands older than about 10 years, but the actual pattern needs to be confirmed with additional measurements. We are still entering data from spring browse sampling. Twig samples of forage species were taken across sample sites to be analyzed for nutritional content. Over winter browse assessment was done before leaf-out in May, 2014.

**Activity Status as of December 31, 2014:**

Winter browse data entry collected in May, 2014 was finished over summer 2014 and initial analysis completed. A total of 30 sites were visited outside of BWCA, with total acreage amounting to 3036 acres sampled. The average size of sites visited was 89 acres (min = 12 acres, max = 559 acres). At each site 5 transects were walked with 20 plots sampled along each. On average, 7 of 13 different browse species were measured at each site. Beaked hazel, aspen, paper birch, and willow were the most common species observed at sites outside of the BWCA. These species were also browsed more than other species, although because they were common they were used less than they were available. Current year browsing was observed on all species measured. Red-osier dogwood was measured as available at 2% of plots; however when present approximately 70% was browsed upon over winter. This is potentially because red-osier dogwood was found most often near roads and trails where it was easily accessible. Red maple was also observed infrequently (2%), but was about 40% browsed upon on those instances.

Sites visited during August and September 2014 were measured for summer browse production and use. Data entry and an initial analysis is now complete. A total of 39 sites were sampled, with 27 being outside the BWCA. Site sizes ranged from 12 to 255 acres (mean = 68 acres). Similar to sites sampled in spring 2014, 7 of 13 different browse species were observed, on average, at each site. The most common species measured at sites were beaked hazel, aspen, mountain maple, and paper birch. Much less browsing was observed in summer, in part because of leaf grow-back early in the season and also because foraging paths are more difficult to observe when leaves are out and views are obstructed.

**Activity Status as of June 30, 2015:**

Over winter browse assessment was done before leaf-out in April and May, 2015 at 36 sites outside of the BWCA under this activity, with total acreage amounting to 2255 acres sampled. 23 of these sites were harvested and 3 were sheared. At each site 5 transects were walked and browse use and availability was recorded at 20 plots along each transect. Twig samples of forage species were taken across sample sites to be analyzed for nutritional content. Over winter browse assessment was done before leaf-out in late May, 2015.

The average size of sites visited was 80 acres (min = 7.3 acres, max = 274 acres). On average, 9 of 14 (range: 6-13) different browse species were measured at each site. Aspen, birch, hazel, and balsam fir were the most common species observed at sites outside of the BWCA. When present, 25% of aspen and birch were browsed, hazel was browsed 21% of the time, and 14% of balsam was browsed upon. Other browse species were

observed less frequently (sugar maple, mountain ash, red osier dogwood, and *Amelanchier* spp.), but also had been browsed upon more than 20% of the time when present (27%, 25%, 29%, 21%, respectively).

#### **Activity Status as of December 31, 2015:**

Summer browse assessment was done before leaf-drop from August-October, 2015 at 41 sites outside the BWCA under this activity, with total acreage amounting to 3,880 acres sampled. At each site 5 transects were walked and browse species use and availability was recorded at 20 plots along each transect. Distance between feeding stations measures density and therefore availability of browse in various patch types. Summer browse assessment is done at the end of summer before leaf-drop and after leaves have stopped being replaced.

The average size of sites visited outside of the BWCA in Fall, 2015 was 50 acres (min = 8 acres, max = 154 acres). An average of 9 of 14 commonly browsed species were present at each site visited outside the BWCA. The minimum number of browse species observed at a site was 5, whereas the maximum observed at a site was 12. The most common species observed was aspen, which was present at 100% of sites. Paper birch was the next most commonly observed species, with presence noted at 98% of sites. Where present, mountain maple, paper birch, and mountain ash were browsed most often. However, evidence of current season browsing was less prevalent during the fall season (2-11% of observed browse species were fed upon when present), than during spring when over-winter browse was measured. This is likely due to higher overall availability of browse food during summer, and also due to re-growth of leaves that were browsed in the early part of summer.

#### **Final Report Summary:**

In Activity 1 browse measurements were made on stands outside of the BWCA burned areas. Browse measurements were done in the spring to measure winter browse use and availability, and in the fall to measure summer browse use and availability. At each site 5 transects were walked and browse species use and availability was recorded at 20 plots along each transect. Over the duration of the project, 176 stands covering 11,536 acres were measured. Stand size ranged from 7 to 559 acres.

Most of the patterns observed in each reporting period were present when all results were compiled and analyzed together. On average, each stand had 6 of the 13 browse species present, with 80% of stands having more than 4 browse species, and 40% of stands having more than 6 browse species. The number of browse species present was similar in harvested stands, sheared stands, and burned stands. Response of browse availability over time was also similar among treatments, with a measurable response of browse availability within 4 years of treatment, and a leveling off of browse availability after 8 to 10 years. The number of browse species is important because moose tend to select areas with a diversity of browse species.

Species composition was similar among harvested stands, sheared stands, and burned stands outside of the BWCA that were measured in this activity. The most common browse species encountered were beaked hazel and aspen, which occurred on about 67% of stands. Paper birch was present on about half of the stands, and mountain maple, willow, balsam fir, and pin cherry were present on about 33% of stands. Chokecherry, juneberry, red osier, and red maple were present on 10% to 20% of stands. Mountain ash, a highly preferred browse species, was present on about 10% of stands.

All species were browsed, with the less common species tending to be browsed on more, and the common species having a lower percentage of browsing. For example, browsing intensity on aspen and hazel, the most common species, was less than 10% across the sampling periods. In contrast, browsing on mountain ash, red-osier and red maple was about 25%.

A preference index showed that mountain ash, mountain maple, red maple, pin cherry, and juneberry were the most preferred species in summer. Aspen, hazel, and willow were the least preferred species in summer, but

these common browse species would provide most of the diet calories because of their abundance. The less common browse species would provide diversity. There was stand level variation in availability of the less common species.

Winter browse preferences were similar to summer browse preferences. The most preferred species in winter were mountain ash, red osier, red maple, and juneberry, while the least preferred species were balsam fir (not eaten in the summer), mountain maple, pin cherry, chokecherry, and aspen. Paper birch, hazel, and willow were eaten approximately in proportion to availability. As in summer, the least preferred species provided much of the diet because of higher availability. Moose would choose to eat the rarer species to increase diet diversity.

Overall, about 12% of twigs were browsed, but there was seasonal variation. About 2% of twigs were browsed in summer, and about 15% of twigs were browsed in the winter. Part of the reason for the lower browsing intensity in summer is that browsing in summer is harder to detect because leaves regrow, and because evidence of browsing is hidden by other leaves. For stands measured in Activity 1, outside of the BWCA, browsing intensity was consistent across treatments. Regardless of whether a stand was harvested, sheared, or burned (post-harvest), browsing level by moose was similar.

The low level of browsing intensity is the main reason we did not fully expend funding, with \$XXXX left under this activity. We prepared browse samples for chemical analysis, but these samples were not submitted for analysis. The relative sizes of twigs, the low percentage of browsing, small changes in climate over the last 20 years, and literature review led to the conclusion that measuring browse quality would not be informative with respect to the decline in the moose population in Minnesota.

The main outcome of this activity is that moose were able to find forest harvest, shear, and burned treatments with browse, because we detected browsing activity in each treatment type. Browsing intensity was relatively low, but this is in part related to the decline in the moose population in northeast Minnesota. There are fewer moose present to eat available browse. A consequence of this is that it is unlikely that browse is limiting the moose population at its current density. The moose population is also affected by other factors. Other projects here in Minnesota completed by the MN DNR have shown a relatively low adult survival rate, and a calf survival rate that is lower than it has been in the past. Adult mortalities are caused by predation and by diseases, parasites, and other health-related issues, while calf mortalities are primarily caused by predation. If survival rates can be increased, then it is possible that browse could be more limiting as the moose population increases. After a large fire in Minnesota in the 1970's moose density increased, and a possible reason for moose density increasing would be the large fires in the BWCA, which were measured in Activity 2.

**ACTIVITY 2:** Moose use of wildfires and prescribed burns in and near the BWCA

**Description:** Analysis of moose habitat quality and moose use (bites, pellet counts) in and near recent forest fires (Pagami Creek, Cavity Lake, Ham Lake), prescribed burns, and the blowdown area. Products would inform the moose habitat restoration process (prescribed burn, slash) and be used for long-term planning (future browse response).

**Summary Budget Information for Activity 2:**

**ENRTF Budget:** \$40,000  
**Amount Spent:** \$ 39,139  
**Balance:** \$ 861

**Activity Completion Date:**

Outcome	Completion Date	Budget
1. Measurement and analysis of browse production in forest fires and blowdown area	1/1/2016	\$28,500
2. Written report on current and future moose habitat in BWCA and adjacent forest	1/1/2016	\$11,500

### **Activity Status as of December 31, 2013:**

Ham Lake, Cavity Lake and Pagami Creek fires were sampled during late summer 2013 for summer browse use and availability for moose (*Alces alces*). 15 sites were visited, 5 in each fire. At each site 5 transects were walked and browse use and availability was sampled at 20 plots along each transect. In the Pagami Creek fire area browse species were abundant, but little sign of use by moose was observed. In Cavity and Ham Lake fires browse species were also abundant. Evidence of winter and summer use by moose was observed, with most winter browsing occurring further from forest edges while most summer browsing was seen along edges of persisting lowland black spruce and black ash forests. The most commonly available browse species were quaking aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), beaked hazel (*Corylus cornuta*), willow (*Salix* spp.), mountain maple (*Acer spicatum*), and pin cherry (*Prunus pennsylvanicus*). Leaf samples of forage species were taken across sample sites in all 3 BWCA wildfire areas. Summer browse species samples are currently being prepared for analysis of nutritional content.

### **Activity Status as of June 30, 2014:**

Ham Lake, Cavity Lake and Pagami Creek fires were sampled during spring 2013 for winter browse use and availability for moose (*Alces alces*). 17 sites were visited, 10 split between the Ham and Cavity Lake fires, and 7 in the Pagami Creek fire. At each site 5 transects were walked and browse use and availability was sampled at 20 plots along each transect. In the Pagami Creek fire area browse species were abundant, but little sign of use by moose was observed as in summer 2013. In Cavity and Ham Lake fires browse species were also abundant. Evidence of winter and summer use by moose was observed. Data is still being entered from the spring sampling. Twig samples of forage species were taken across sample sites in all 3 BWCA wildfire areas to be analyzed for nutritional content.

### **Activity Status as of December 31, 2014:**

In the Ham Lake, Cavity Lake, and Pagami Creek fire areas 12 sites were sampled during late summer 2014 for summer browse productivity and use by moose. The same protocol was used in late summer as was used in spring 2014. No sugar maple, red maple, or mountain ash were observed during fall sampling while all browse species except sugar maple were observed in spring 2014. Browse species were abundant at all sample sites within these burned areas. Approximately 7 of 13 browse species were observed in each plot, on average. The most common species was aspen, making up 50% of species measured in spring 2014 and 25% in fall 2014. This is in contrast to sites outside of BWCA burned areas where beaked hazel tends to be more dominant. Evidence of browsing in summer and winter was observed. It appeared that most browsing by moose has occurred near edges of burned areas and also along edges of remnant forest patches within the burns.

### **Activity Status as of June 30, 2015:**

In the Ham Lake fire area along the Gunflint Trail, 10 sites were sampled during early spring 2015 for winter browse availability and use by moose. The same protocol was used in spring 2015 as was used in spring 2014. All 14 browse species were recorded at BWCA and adjacent burned sites in spring 2015. Browse species were abundant at all sample sites within these burned areas. Approximately 8 of 14 browse species were observed in each plot, on average (range: 4-10). Aspen, birch, and pin cherry were measured at all 10 sites sampled, whereas balsam fir was only measured at one site. Sugar maple and choke cherry were not observed at the 10 BWCA sites sampled in spring 2015. In total, 7.5 of measured available browse species were foraged upon by moose over winter 2015. Aspen was measured as present 22% of the time and was browsed upon 5% of the time, birch was observed 21% of the time and was also browsed upon 5% of the time over winter. Hazel was

present 11% of the time and was most heavily browsed upon (16% browsed). This is consistent with the seasonal variation in diet with hazel present in winter but not in summer (Portinga and Moen in press)

### **Activity Status as of December 31, 2015:**

The Pagami Creek Fire occurred in summer 2011 and is located toward the western part of the study area. During Fall 2015, 12 sites were visited within the Pagami Creek fire boundaries, with a focus along the western edge. The same protocol was used in Fall 2015 as was used in spring 2015 to assess browse availability and use by moose. 10 of 14 common browse species were observed, however the average species richness at a site was 5, which is nearly half of that observed elsewhere in older BWCA fires (Ham and Cavity Lake Fires) and also in sites outside the BWCA. The dominant species was aspen, which was measured at 100% of sites. Willow and paper birch were also observed at 100% of sites, followed by pin cherry observed at 83% of sites. Balsam fir, mountain ash, and sugar maple were absent. No current season browsing was documented. This is likely because historically the surrounding area has had lower moose densities relative to the fires along the Gunflint Trail and also because the Pagami Creek fire has not grown back enough yet to provide the diversity of forage species available elsewhere and also because access to nearby mature forest for cover is limited.

### **Final Report Summary:**

In Activity 2 we measured browse response to the Ham Lake, Cavity Lake and Pagami Creek fires in and adjacent to the BWCA. We visited 66 sites and at each site 5 transects were walked and browse use and availability was sampled at 20 plots along each transect. Most of the patterns presented in each reporting period were present when all results were compiled and analyzed together, and results were generally similar to what was found in Activity 1, outside of the BWCA and in stands treated with forest harvest, shearing or burning. On average, 5 of the 13 browse species were present in the BWCA fires, with 80% of stands having more than 3 browse species, and 40% of stands having more than 5 browse species. The BWCA burns tended to have 1 fewer species than the managed stands measured in Activity 1. However, response of browse availability over time was similar, with a measurable response of browse availability within 4 years of treatment, and a leveling off of browse availability after 8 to 10 years. The number of browse species is important because moose tend to select areas with a diversity of browse species.

Species composition was a little different in the BWCA burn compared to the treatments in Activity 1. Aspen was most common, and present on 84 percent of the transects. Paper birch, willow, and pin cherry were present on about half of the transects. The largest difference was in availability of hazel, which was only present on about 30% of the transects. Other species were present on about 15% or fewer of the transects. Essentially, the browse response in the BWCA burn was to have slightly fewer species within a transect, and to have a larger number of rare species. Species that were rare in Activity 1 were also rare in the BWCA burn transects.

Browsing intensity was less in the BWCA burned area, which is consistent with the moose density estimates in the MN DNR moose survey. The browse measurements in this project were taken before the increases in moose density that appear to be occurring in recent moose surveys. Overall, the summer browsing intensity was about 1% (compared to 3% in the Activity 1 treatment areas), and winter browsing intensity was about 11% (compared to an overall average of about 15% in the Activity 1 treatment areas). Browsing was measured mostly in the Ham Lake and Cavity Lake fire areas, there was very little browsing or sign of moose in the Pagami Creek fire, likely because of low densities of moose in the adjoining areas and also because browse regrowth had not occurred.

As in Activity 1, all species were browsed, with the less common species tending to be browsed on more, and the common species having a lower percentage of browsing. Species browse preferences in winter were similar to species preferences in Activity 1, with the main difference being a lower browsing percentage in the BWCA burned areas. Preference for red maple, mountain maple, and chokecherry increased in the BWCA burned areas

relative to the species preferences in Activity 1. There was not enough summer browsing detected to make any inferences about preferences, although it is likely that species preference would be similar.

The primary outcome of this Activity was that the large fires in the BWCA have regenerated browse that would be used by moose. The species composition was similar to the species composition in the treatment areas of Activity 1, with the exception being less hazel browse, although this was balanced by an increase in aspen. In the Pagami Creek fire area browse species were abundant, but little sign of use by moose was observed, although the first sampling year was only 2 years after the original burn. With the observed presence of browse in the Ham Lake and Cavity Lake fire areas, it is likely that abundant browse would be present in the Pagami Creek fire area by 2015 to 2016, and we did start measuring increased browse in the Pagami Creek fire transects by the end of this project.

## **V. DISSEMINATION:**

### **Description:**

#### **Status as of December 31, 2013:**

1. Interviews on the general moose issue were given to newspaper reporters, and we showed Josephine Marcotty (Minneapolis Star-Tribune) some of the field sites for this project on August 1, 2013 in preparation for a larger story.
2. 18 presentations by project representatives on moose in Minnesota were given in 2013 (ENRTF funds were not used for travel outside of MN).
  - a. 2 presentations at the national The Wildlife Society meetings in October 2013
  - b. 1 presentation at a wildlife health meeting in International Falls, MN in October 2013
  - c. 1 presentation at a moose health workshop in Sweden in October 2013
  - d. 1 presentation by Amanda McGraw at the Ashland Science on Tap program series in Ashland, WI in November 2013
  - e. 1 presentation at the University of Minnesota Duluth in December 2013
  - f. 12 presentations at the 2013 Moose Research and Management meeting in Cloquet, MN

#### **Status as of June 30, 2014:**

1. Interviews on the general moose issue in Minnesota were given to several newspaper reporters including John Myers (Duluth News Tribune) and others.
2. Presentation on status of moose in Minnesota to the Environment and Natural Resources Policy Committee of the Minnesota House of Representatives on February 25, 2014. Dr. Glenn DelGiudice (MN DNR) was the other presenter.
3. 30 presentations by project representatives on moose and interactions with other species (deer, wolves, parasites) in Minnesota were given from January to June 2014 (ENRTF funds were not used for travel outside of MN).
  - a. 1 presentation (Moose Research Update) at the DNR Round Table, Bloomington, MN, January 10th, 2014
  - b. 9 presentations and 1 poster at the Minnesota chapter of The Wildlife Society meetings in February 2014
  - c. 1 presentation at Lake Superior Binational Forum in Ashland, WI in March, 2014
  - d. 2 presentations at the Minnesota Chapter of the Society for Conservation Biology in Apple Valley, MN in April 2014

- e. 2 presentations at University of Minnesota Duluth classes, 2 Presentations at St. Catherine University in St. Paul, MN, and 4 Presentations at Concordia College in Moorhead, MN in spring semester 2014
- f. 6 presentations at 48th North American Moose Conference and Workshop in Girdwood, AK in May 2014
- g. 1 presentation at the Natural Resources Research Institute in Duluth, MN in April 2014
- h. 1 presentation on the effect of Changing Climate on NE MN Moose at a workshop given by the DNR on Interpreting climate change in NE MN in Duluth, MN in April 2014.

**Status as of December 31, 2014:**

1. 6 Presentations were given in Fall 2014 in which the moose project was discussed (ENRTF funds were not used for travel outside of MN):
  - a. Biology Dept. seminar given by Juliann Terry 11/7/2014 at the University of Minnesota Duluth.
  - b. Biology Dept. seminar given by Tim Cyr 12/7/2014 at the University of Minnesota Duluth.
  - c. 2 presentations at the Great Lakes Native American Fish and Wildlife Conference at Lac du Flambeau, Wisconsin September, 2014.
  - d. Guest lecture to graduate level class at the University of Minnesota Duluth 9/22/2014.
  - e. Geospatial Analysis Center Symposium at University of Minnesota Duluth 10/24/2014.
2. Publications during this period included (some based on previous ENRTF project):
  - a. McGraw, A.M., J. Terry, and R. Moen. 2014. Pre-Parturition Movement Patterns and Birth Site Characteristics of Moose in Northeast Minnesota. *Alces* 50:93-103.
  - b. VanderWaal, K.L., S.K. Windels, B.T. Olson, T. Vannatta, and R. Moen. 2014. Spatial epidemiology of liver fluke and meningeal worm in white-tailed deer in northern Minnesota, USA. *Parasitology* 142:706-718.
  - c. Olson, B., S. K. Windels, M. Fulton, R. Moen. 2014. Fine-Scale Temperature Patterns in the Southern Boreal Forest: Implications for the Cold-Adapted Moose. *Alces*: 50:105-120.
  - d. Cyr, T., S.K. Windels, R. Moen, and J. Warmbold. 2014. Diversity and abundance of terrestrial gastropods in Voyageurs National Park: Implications for risk of individual moose to *Parelaphostrongylus tenuis* infection. *Alces*:50:121-132.
  - e. Ward, R. Edited by R. Moen. 2014. Identifying woody species browsed by moose in northeastern Minnesota. NRRI Technical Report No. NRRI/TR-2014/34.
  - f. Ward, R.L., and R. Moen. 2014. Effects of stand age on species composition and browse density in northeastern Minnesota. NRRI Technical Report No. NRRI/TR-2014/36.
  - g. Jordan, P.A. Edited by R. Moen. 2013. A Sampling Protocol to Estimate Impacts of Moose and Snowshoe Hare on the Woody Vegetation of Isle Royale National Park. NRRI Technical Report No. NRRI/TR-2013-44.
  - h. Joyce, M., and R. Moen. 2014. Mapping forest harvest in northeastern Minnesota using aerial photographs and high resolution satellite imagery. NRRI Technical Report No. NRRI/TR-2014-17.

**Status as of June 30, 2015:**

1. 17 Presentations were given in Winter and Spring 2015 in which the moose project was discussed (ENRTF funds were not used for travel outside of MN):
  - a. 1 presentation (Research update: Deer in northeast Minnesota) at the Minnesota DNR deer committee meeting, June 2015
  - b. 6 presentations were given at the MN/WI The Wildlife Society chapter meetings in Duluth, Minnesota in February 2015

- c. 1 presentation was given at the 2015 Forest and Wildlife Research Review, Cloquet Forestry Center, Cloquet, Minnesota on 2/24/2015
  - d. 2 presentations were given at the 2015 Prairie to Woods Whitetails 2015 Exposition, Parkers Prairie, MN 3/21/2015.
  - e. 1 class lecture in Ecology given to UMD students, Duluth, MN, 4/9/2015.
  - f. 2 presentations were given at Coe College, Cedar Rapids, IA, on 4/13/2015.
  - g. 4 presentations were given at the North American Moose Conference and Workshop in Colorado in April 2015
2. Publications during this period included (some based on previous ENRTF project):
- a. Portinga, R.L. and R. Moen. 2015. Measuring actual and effective browse availability for moose using a new method in northeastern Minnesota. *Alces*, in press.
  - b. Terry, J. 2015. The Habitat of Winter Ticks (*Dermacentor albipictus*) In The Moose (*Alces alces*) Range of Northeast Minnesota. M.S. Thesis, University of Minnesota.
  - c. Cyr, T. 2015. Spatial and temporal abundance of gastropod intermediate hosts in northeastern Minnesota with implications for *Parelaphostrongylus tenuis* risk in moose. M.S. Thesis, University of Minnesota.
  - d. Moen, R. 2014. Restoring moose foraging habitat in Lake Superior Uplands. NRRI/TR-2014/47.
  - e. Ibrahim, Y.C. and R. Moen. 2014. Manual for Prey Species Identification in Gray Wolf Scats. NRRI/TR-2014/45.
3. Media contacts during this period included:
- a. Media day visits to restored moose habitat hosted by The Nature Conservancy, May 2015.
  - b. Multiple interviews with newspaper and radio reporters in early May, 2015.
  - c. Writers Workshop for the Institute for Journalism & Natural Resources, Hawk Ridge, Duluth, MN. 6/24/2015.

### **Status as of December 31, 2015:**

1. 5 Presentations were given in Summer and Fall 2015 in which the moose project was discussed (ENRTF funds were not used for travel outside of MN):
- a. Mammal research at UMD. R. Moen. Graduate School Breakfast Meeting. UMD Campus. 10/6/15.
  - b. Mammal research at UMD. R. Moen. Biology Dept. Seminar, UMD Campus. 10/23/15.
  - c. Lymnaeid Snails of North America: Distribution and Susceptibility to Giant Liver Fluke. J. Trevor Vannatta, R. Moen. The Wildlife Society's 22nd Annual Conference. Winnipeg, Manitoba. 10/18/15.
  - d. Using LiDAR Data To Interpret Behavior specific Habitat Use By Moose. R. Moen, M. Joyce, Xuan Li, N. McCann, S. Windels. The Wildlife Society's 22nd Annual Conference. Winnipeg, Manitoba. 10/18/15.
  - e. Characterizing a declining moose population using a population genetics approach. T. Tjepkes, R. Moen, J. Strasburg. Second Midwest Popgen Meeting. University of Michigan: School of Public Health; Ann Arbor, MI. 7/25/15.
2. Publications during this period included (some based on previous ENRTF project):
- a. Street, G.M., J. Fieberg, A.R. Rodgers, M. Carstensen, R. Moen, S.A. Moore, S.K. Windels, and J.D. Forester. 2016. Habitat functional response mitigates reduced foraging opportunity across bioclimatic gradients: implications for animal fitness and space use. *Landscape Ecology* 31:1939–1953.

- b. McCann, N.P., R.A. Moen, and S.K. Windels. 2016. Influence of temperature on summer bed site selection by moose (*Alces alces*). *Wildlife Biology* 22(5):228-237.
- c. Ditmer, M.A., R.A. Moen, S.K. Windels, J.D. Forester, T. Ness and T.R. Harris. 2017. Moose at their bioclimatic edge alter their behavior based on weather, landscape, and predators. *Current Zoology* zox047, <https://doi.org/10.1093/cz/zox047>.
- d. Vannatta, J.T. and R. Moen. 2016. Giant Liver Fluke in Moose: Just a Fluke? *Alces* 52:117-139.
- e. Yvette Ibrahim. M.S. 2015. Wolf scat analysis for diet composition. Integrated BioSciences program, University of Minnesota, Twin Cities.
- f. Tessa Tjepkes. M.S. 2015. Genetic Analysis of Moose Populations from Minnesota and Yellowstone National Park. Integrated BioSciences program, University of Minnesota, Twin Cities. Co-Advised with Dr. Jared Stasburg (UMD Biology).

3. Media contacts during this period included:

- a. NRRI researcher looks at liver fluke impact on deer and moose J. Trevor Vannatta. Northlands News Center. 8/4/15.

**Final Report Summary:**

Overall this project resulted in significant outreach to the public and to resource management agency personnel. Over the course of the project we had 71 presentations to different audiences, ranging from professional conferences, college courses, and the public. There were 5 M.S. graduate students who were supported in part by this project and have already graduated, and 1 Ph.D. student who defended in spring 2018. Publications arising from this project include 5 M.S. theses, 1 Ph.D. thesis (not quite completed), 9 technical reports, and 9 peer-reviewed publications. There were also at least 8 different media contacts which appeared in print, on the radio, or on television.

Goal 3 identified in the work plan was to continue to involve the public, biologists, and organizations in a coordinated effort to slow or prevent a continuing decline of the NE MN moose population. This is important because of the combined research effort among biologists, agencies, and organizations. Concern about moose in Minnesota is real, and is evident in the way moose research transcends agency jurisdiction and even the international boundary. Collectively, the research project, the meetings of Minnesota moose biologists, and involvement of the public made it possible to meet this goal.

**VI. PROJECT BUDGET SUMMARY:**

**A. ENRTF Budget:**

Budget Category	\$ Amount	Explanation
Personnel:	\$172,328	Manager @ 16% for 36 months; grad student @ 50% for 36 months; undergrad @ 15% for 27 months and 11% for 9 months; field tech @ 53% for 36 months.
Professional/Technical/Service Contracts:	\$2,819	plant chemistry analysis \$12,000; satellite service for downloading data \$3,000
Equipment/Tools/Supplies:	\$2,900	Batteries, field sampling tools and supplies (twig cutters, bags, ziplocks, bug dope), moose capture supplies (drugs, sample kits, bags, snowmobile gas)
Travel Expenses in MN:	\$17,831	Yrs 1 and 2: 6 people * 25 days * \$15/day camping food = \$2,250 food, other expenses for travel to mortalities/conferences and

		presentations (in MN only: \$1,357. All Yrs vehicle mileage: ~18,000 mi x \$.555 per year on vehicle = \$9,990 mileage + \$10/day vehicle rental charge (departmental vehicle) * 144 days = \$1,440.
Other:	\$0	
<b>TOTAL ENRTF BUDGET:</b>	<b>\$195,519</b>	

**Explanation of Use of Classified Staff:**

**Explanation of Capital Expenditures Greater Than \$3,500:** N/A

**Number of Full-time Equivalent (FTE) funded with this ENRTF appropriation:** 6.0

**Number of Full-time Equivalent (FTE) estimated to be funded through contracts with this ENRTF appropriation:** N/A

**B. Other Funds:**

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
<b>Non-state</b>			
NSF to be submitted January 2013. Fed grants cannot be committed as match, A-21 Circular. \$155,000	\$	\$	
<b>State</b>			
Base support from NRRI/UMD to R. Moen (secured)	\$8,485	\$	Funding for this project
Base support from NRRI/UMD to R. Moen (secured)	\$16,970		Funding for this project
<b>TOTAL OTHER FUNDS:</b>	<b>\$25,455</b>	<b>\$</b>	

**VII. PROJECT STRATEGY:**

**A. Project Partners:** Dr. Ron Moen, Natural Resources Research Institute, University of Minnesota Duluth is project manager.

The NE MN Moose Habitat Collaborative created the LS-OHF proposal that is recommended for funding. Collaborative members include MDHA (fiscal agent), Cook, Lake, and St. Louis County Forestry, Superior National Forest, tribal representatives, and The Nature Conservancy.

**MN DNR.** Coordinating with NRRI. **Dr. Glenn DelGiudice**, Primary contact.

**The Minnesota Zoo** is continuing its involvement with moose. Outreach and education will be coordinated with zoo staff.

The overall moose GPS collar projects includes cooperators from **Voyageurs National Park (Dr. Steve Windels)**, **Grand Portage Indian Reservation (Dr. Seth Moore)**, **1854 Treaty Authority (Andrew Edwards)**, and **Quetico Provincial Park in Ontario (Lisa Solomon)**.

**B. Project Impact and Long-term Strategy:** Collaboration among scientists and managers in northeast Minnesota to increase the moose population will continue. There may be some smaller scale moose research needs in the future, but the current collaborative and complementary research and habitat projects should answer many of the immediate questions and allow limited funds to be directed to projects that will provide most benefit to moose. In the next three to five years we should have answers on what is needed to keep moose in Minnesota.

**C. Spending History:**

Funding Source	M.L. 2007 or FY08	M.L. 2008 or FY09	M.L. 2009 or FY10	M.L. 2010 or FY11	M.L. 2011 or FY12-13
Current LCCMR appropriation				\$190,000	
Lessard-Sams OHF funding. \$976,000 to MDHA for moose habitat restoration 2012-2015, \$2,000,000 recommended for funding 2013-2016.					\$976,000 \$2,000,000
Voyageurs National Park (~\$300K), Grand Portage (~\$200K), and Quetico Provincial Park (~\$100K) are awarded funding but A-21 Circular of the Federal Government does not allow us to list dollar amounts as match (all Fed. Funds are Secured). The moose collared in these projects are also providing data for this project. In addition, \$192K was obtained for moose habitat restoration from the EPA Great Lakes Restoration Initiative (Secured).					

**VIII. ACQUISITION/RESTORATION LIST: N/A**

**IX. MAP(S):**

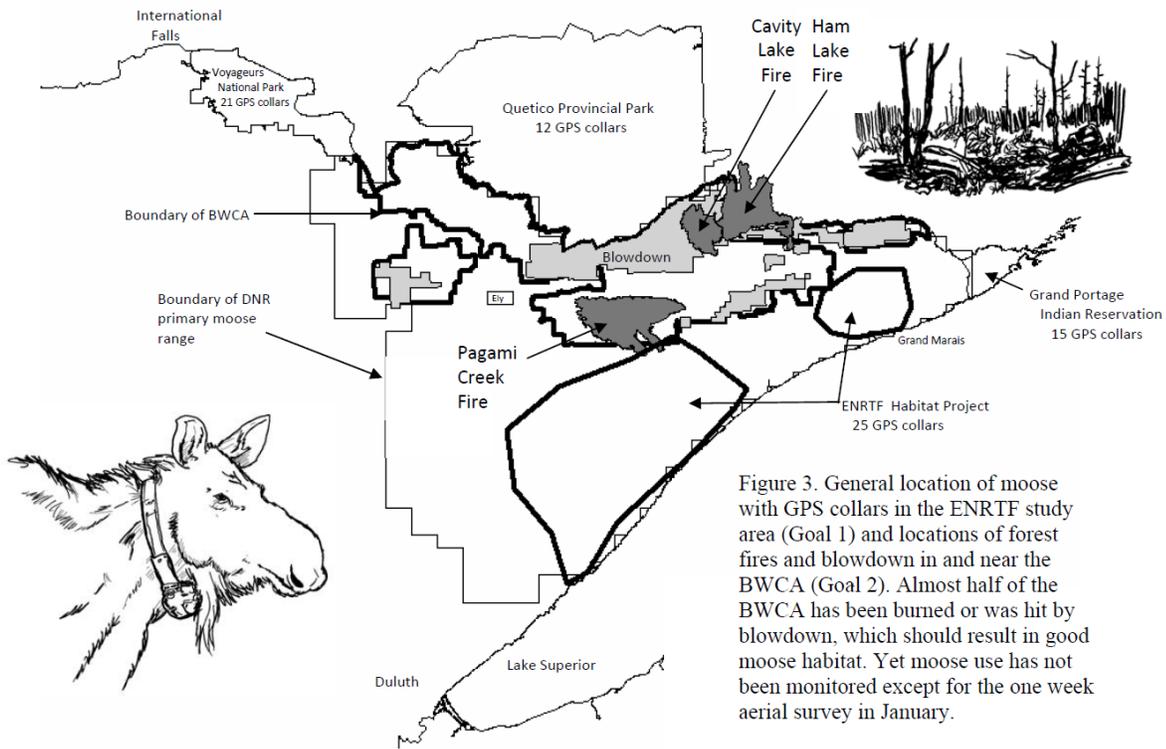


Figure 3. General location of moose with GPS collars in the ENRTF study area (Goal 1) and locations of forest fires and blowdown in and near the BWCA (Goal 2). Almost half of the BWCA has been burned or was hit by blowdown, which should result in good moose habitat. Yet moose use has not been monitored except for the one week aerial survey in January.

**X. RESEARCH ADDENDUM:**

**XI. REPORTING REQUIREMENTS:**

Periodic work plan status update reports will be submitted not later than December 31, 2013, June 30, 2014, December 31, 2014, June 30, 2015, and December 31, 2015. A final report and associated products will be submitted between June 30 and August 15, 2016 as requested by the LCCMR.

Final Attachment A: Budget Detail for M.L. 2013 Environment and Natural Resources Trust Fund Projects												
Project Title: Moose habitat restoration techniques in northeastern Minnesota												
Legal Citation: ML 2013, Chap. 52, Sec 2, Subd. 4(g)												
Project Manager: Ron Moen												
M.L. 2013 ENRTF Appropriation: \$200,000												
Project Length and Completion Date: 3 years, 06/30/2016												
Date of Update: 4/11/2018												
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Activity 1 budget 12/14/2018	Amount Spent	Balance	Activity 2 Budget	Activity 2 budget 12/14/2018	Amount Spent	Balance	TOTAL BUDGET	TOTAL REVISED BUDGET	TOTAL Spent	TOTAL BALANCE
<b>BUDGET ITEM</b>												
<b>Personnel (Wages and Benefits) Total (W&amp;B):</b>	<del>\$190,400</del>	\$136,619	\$136,619	\$0	<del>\$34,169</del>	\$35,709	\$35,709	\$0	<del>\$164,269</del>	\$172,328	<del>\$172,328</del>	0
R. Moen, Manager, 15 mos @ 25%=\$21,767; \$16,136 Salary, \$5,631, 21 mos @ ~11% = \$19,217, \$14,245 salary, \$4,972 fringe. (Fringe 34.9%)	<del>\$33,000</del>	\$34,438	\$34,438	\$0	<del>\$8,000</del>	\$8,610	\$8,610	\$0	<del>\$41,000</del>	\$43,048	<del>\$43,048</del>	0
Grad Res Asst, 15 months @ 50%=\$31,000; \$24,585 Salary, \$6,415 (Fringe 26.1%)	<del>\$26,000</del>	\$19,924	\$19,924	\$0	<del>\$6,000</del>	\$4,981	\$4,981	\$0	<del>\$31,000</del>	\$24,905	<del>\$24,905</del>	0
Undergrad Res Asst, 27 mos @ 15%, 9 mo @ 11%=\$8,169; \$8,051 Sal, \$118 (Fringe 7.61% on 9 mo only)	<del>\$6,000</del>	\$16,157	\$16,157	\$0	<del>\$2,169</del>	\$4,039	\$4,039	\$0	<del>\$8,169</del>	\$20,196	<del>\$20,196</del>	0
Adv Status GRA, 26 mos @ 25%, 3 mo @ 50%=\$34,722; \$32,618 Sal, \$8,880 Frng (9 mo @16.76%, 1 mo @ 26.1%, tuition-1227 hrs @ \$2.67/hr)	\$30,000	\$30,000	\$30,000	\$0	<del>\$8,000</del>	\$8,080	\$8,080	\$0	<del>\$38,000</del>	\$38,080	<del>\$38,080</del>	0
Field/lab tech, 36 mos @ 53%=\$46,100; \$42,666 Salary, \$3,834 Fringe (9.07%)	\$36,100	\$36,100	\$36,100	\$0	\$10,000	\$10,000	\$9,999	\$1	<del>\$46,100</del>	\$46,100	<del>\$46,099</del>	1
<b>Professional Services</b>												
DNR, Spotter plane for captures and mortalities (30 hrs @ \$250/hr (estimated hours and cost/hr)). Budget line item zeroed out and funds transferred (see amendment request). DNR paid for capture costs with their project.	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	0
TBD, Helicopter for moose capture (7 moose @ ~\$1,070/moose estimate). Budget line item zeroed out and funds transferred (see amendment request). DNR paid for capture costs with their project.	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	0
TBD, Plant chemistry analysis (~480 samples @ \$25/sample (Estimate, will be bid out))	<del>\$0,600</del>	\$3,081	\$0	\$3,081	<del>\$2,400</del>	\$860	\$0	\$860	<del>\$12,000</del>	\$3,941	\$0	3,941
Iridium satellite services for downloading data from moose collars	\$3,000	\$3,000	\$2,819	\$181	\$0	\$0	\$0	\$0	<del>\$3,000</del>	\$3,000	<del>\$2,819</del>	181
Lotek Wireless, Inc. Collar refurbishment (7 collars @ estimated \$1,143 / collar. Collars refurbished from ML 2010, Chap. 362, Sec. 2, Subd. 3(k). Not economically efficient to refurbish collars with project switch to Vectronics collars. Line item set to 0 and funds transferred (see budget amendment request).	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	0
<b>Supplies:</b>												
Batteries, field sampling tools and supplies (twig cutters, bags, ziplocks, bug dope), moose capture supplies (drugs, sample kits, bags, snowmobile gas)	\$2,300	\$2,300	\$2,300	\$0	\$600	\$600	\$600	\$0	<del>\$2,900</del>	\$2,900	<del>\$2,900</del>	0
<b>Travel:</b>												
Yrs 1 and 2: 6 people * 25 days * \$15/day camping food = \$2,250 food, other expenses for travel to mortalities/conferences and presentations (in MN only) \$1,357. All Yrs vehicle mileage: ~18,000 mi x \$.555 per year on vehicle = \$9,990 mileage + \$10/day vehicle rental charge (departmental vehicle) * 144 days = \$1,440.	\$15,000	\$15,000	\$14,642	\$358	<del>\$2,834</del>	\$2,830	\$2,830	\$0	<del>\$17,831</del>	\$17,830	<del>\$17,472</del>	358
<b>COLUMN TOTAL</b>	<b>\$160,000</b>	<b>\$160,000</b>	<b>\$156,380</b>	<b>\$3,620</b>	<b>\$40,000</b>	<b>\$40,000</b>	<b>\$39,139</b>	<b>\$861</b>	<b>\$200,000</b>	<b>\$200,000</b>	<b>\$195,519</b>	<b>\$4,481</b>