

2016 Moose Habitat Survey

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Introduction

Fire and timber harvest are generally believed to be beneficial to moose (*Alces alces*) through the creation of early successional forest. A study of moose response to the 1971 Little Indian Sioux Wildfire in Minnesota by Peek (1974), and other authors (Lenarz et al. 2011 and Peek et al. 1976), support this view. Public and media interest following recent large fires in northeastern Minnesota has often included questions regarding benefits to moose. Along with other reasons, local timber harvest is frequently justified as creating better moose habitat (Superior National Forest [SNF] 2011).

Constitutionally dedicated funding for Minnesota wildlife habitat and a declining moose population has increased interest and support for moose habitat enhancement and led to discussions among managers about where and how to fund habitat projects using timber management and prescribed fire (M. Johnson, Minnesota Deer Hunters Association, personal communication). As a result, tribal, state and federal moose managers have expressed interest in better understanding whether or not moose have responded positively to recent large wild and prescribed fires, and similarly, whether moose will respond positively to proposed timber management projects. Although moose habitat quality is not necessarily seen as responsible for the continuing decline in moose numbers, the Minnesota Moose Research and Management Plan recognizes that habitat management may have an important role to play in mitigating this decline (Minnesota Department of Natural Resources [DNR] 2011).

Prior to 2012 the stratified random sampling design for the annual moose population survey precluded regular observations of large habitat changes. Survey plots were randomly selected from high, medium or low moose density areas, and many years might elapse before the same survey plot was flown again. This made it difficult to obtain local knowledge on how moose responded to a large habitat change and how that response changed over time. To help fill this knowledge gap, this habitat survey was initiated in January, 2012. The primary objectives of this survey are to detect moose response due to wildfire, prescribed (Rx) fire, and timber management activities and determine how that response changes over a long period of time. This information is intended to assist decision-making regarding where and how to prioritize funding and effort for moose habitat management, and provide more accurate and local information to managers and stakeholders about benefits to moose.

Methods

In order to minimize costs and time requirements and maximize comparison with other moose demographic data, the habitat survey is flown concurrent with and using the same methods as the annual moose population survey (DelGiudice, 2016). The population survey uses a stratified random sampling technique with 3 strata based on expected moose density. The demographic data from the habitat survey are incorporated into the population survey results through the use of a permanent 4th stratum.

Habitat survey plots were located across moose range in northeastern Minnesota (Figure 1.) All survey plots were rectangular (5 x 2.67 mi.) and 8,544 acres in size. The survey was flown using 2 DNR Bell Jet Ranger (OH-58) helicopters. The program DNRSurvey, on Toughbook® tablet style computers, was used to record survey data. Visibility bias was considered using a sightability model to account for visual obstruction

(Giudice et al. 2012). Visual obstruction was defined as the proportion of screening cover within four animal lengths (approx. 30 ft radius circle) of the first animal seen as measured from the location and angle of the initial sighting. If more than 1 moose was observed at a location, visual obstruction was based on the first moose sighted. A linear logistic regression equation (the sightability model; Giudice et al. 2012) was used to estimate the mean probability of detection for each moose-group observation given their visual obstruction reading, and then moose counts were adjusted for sampling and sightability (via a Horvitz-Thompson type estimator) and summed by stratum to obtain stratum-specific estimates of abundance. An estimate of total abundance was computed by summing stratum-specific estimates. Detection is a random process (similar to flipping a coin), and therefore adjusted counts will be more reliable as sample size increases (e.g., at the stratum level). Thus, the interpretation of adjusted counts at the plot level should be viewed as index of abundance, and may be best suited for tracking changes to a plot's visual obstruction levels as a result of vegetation changes over time.

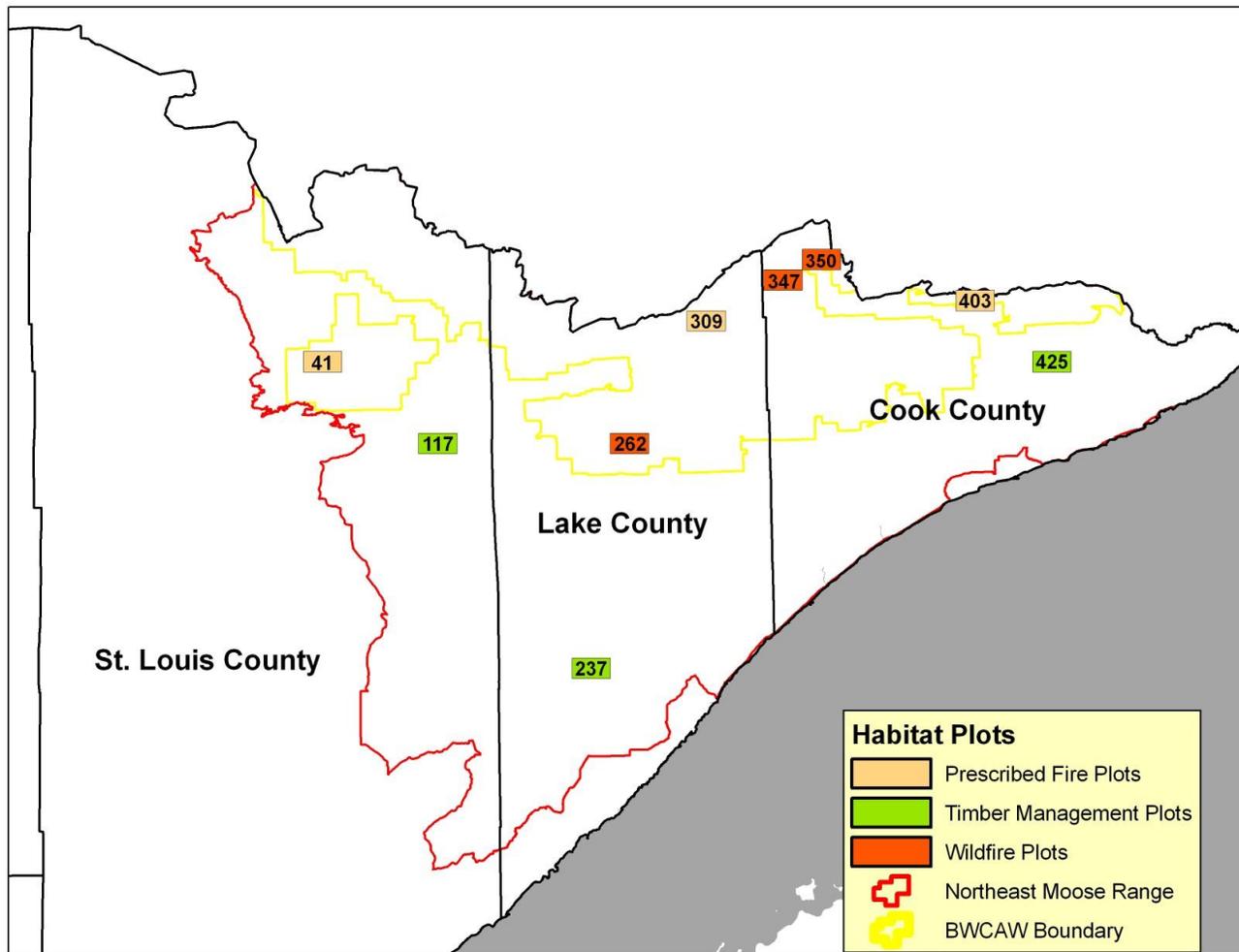


Figure 1. Locations and treatment types of the 9 moose habitat survey plots.

After consultation with local tribal, DNR and SNF staff in late 2011, 3 plots in each of 3 treatments types were selected to be flown as part of this survey. Treatment types were defined as wildfire, prescribed (Rx) fire, and broadly as timber management. Plots were selected for a variety of reasons, including geographic distribution, availability of previous years' survey data, percentage of a plot impacted by a treatment, and time since treatment or until a planned treatment. Descriptions of vegetative type and ages, ownership patterns, and harvest history for timber management plots were obtained from local DNR and SNF wildlife staff. Information on fire history, acres burned, and 1999 blowdown patterns was obtained from SNF geographic information

system (GIS) layers. Moose locations in this report are overlaid on summer 2013 Farm Service Agency photos provided by Minnesota Geospatial Image Service. The intention is to fly each of the 9 habitat plots on an annual basis for an estimated 20 years to help minimize the influence of annual variation of observed moose, and to determine how moose response to a disturbance or treatment changes over time. When available, plot data from previous surveys back to 2005 are included in this report. Results prior to 2005 are not directly comparable to results in this report due to changes in plot design and survey techniques. The number and location of moose observed and the corrected estimate of moose numbers based on visibility bias are reported for each plot.

Results and Discussion

Survey conditions in 2016 were described by DelGiudice (2016). The survey was initiated on 4 January and completed on 15 January with 9 actual survey days. Including the 9 habitat plots, 52 plots were flown in 2016. Snow depths were estimated at <8" on plot 41, 8-16" on plots 117, 237, 262, 347 and 350 and >16" on plots 309, 403 and 425. Results for this habitat survey should be considered in the context of the entire northeastern Minnesota moose population. After declining from approximately 8800 moose in 2006, the population appears to have stabilized in recent years at around 4000 moose (Figure 2). In 2016 the average number of moose seen on all 52 survey plots was 9.7 and the median value was 5.5 moose.

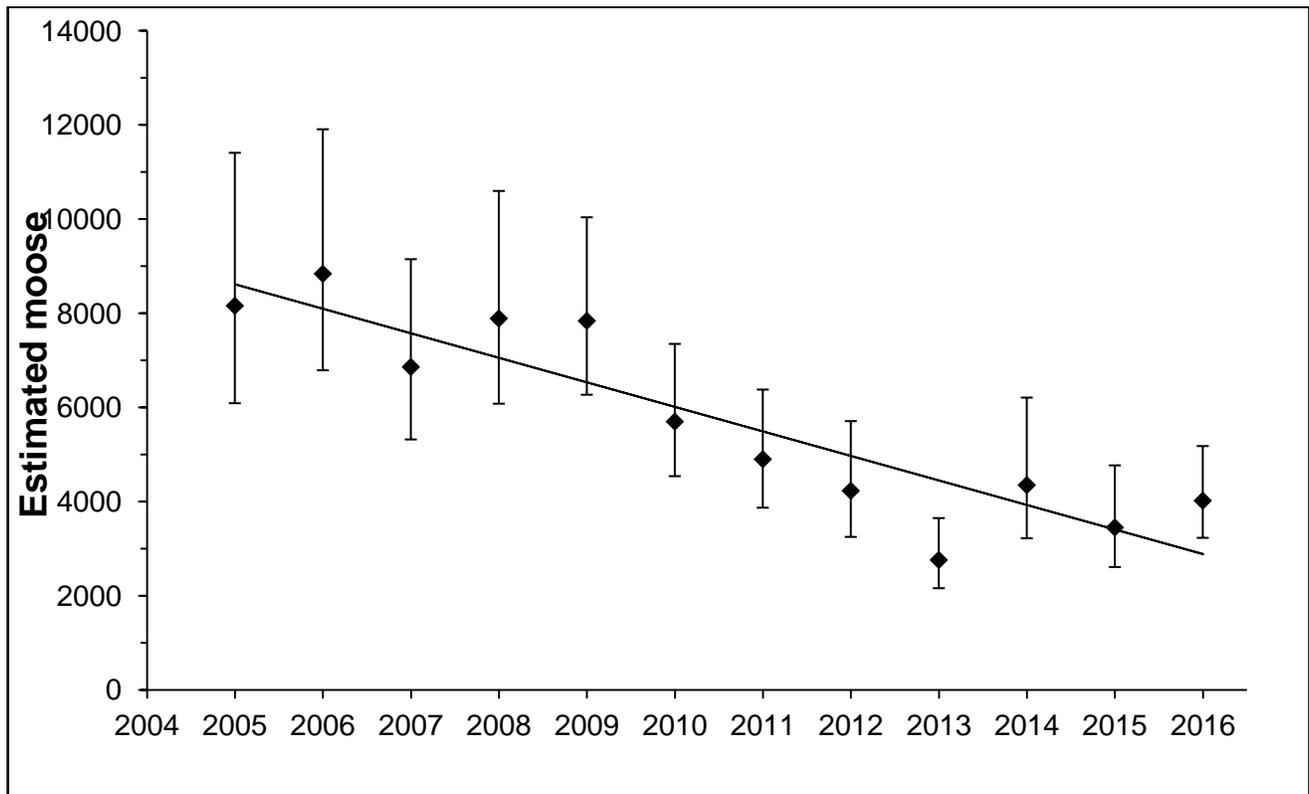


Figure 2. Point estimates, 90% confidence intervals, and trend line of estimated moose numbers in northeastern Minnesota, 2005-2016 (DelGiudice, 2016).

Timber Management Plots

Plot 117: Twin-Mitchell Project Area

Plot 117 is located 7 miles southwest of Ely (Figure 3). Land ownership within the plot is a mixture of approximately 31% St. Louis County, 29% SNF, 19% State of Minnesota, 16% private, and 5% public waters of Minnesota. There is one DNR administered Scientific and Natural Area located partially within the plot boundary. It accounts for <1% of the State ownership and is mainly old growth red and white pine. The plot is a mix of upland forest with intermixed lowlands of black spruce, mixed swamp conifer, alder and lowland brush and grass. The upland vegetation is a mix of aspen/spruce-fir, red pine, white pine and jack pine cover types. The upland forest is a mix of ages ranging from 0-9 age classes to some red and white pine stands that are 100+ years old. The majority of private lands are mature and older forest.

State land ownership accounts for 1,528 acres of the total plot and is comprised of 70% conifers, 24% hardwoods, and the remaining 6% a mix of lowland brush, muskeg, permanent and non-permanent water habitats. Approximately 55% of the State conifer stands are 0-20 years old, 7% are 20-40 years, and 13% are between the ages of 40-85. The remaining 25% includes stands of white pine, red pine, cedar and black spruce that are 100+ years old. Approximately 16% of the State hardwood stands are 0-10 years in age, 35% are 10-30 years, and 34% are between the ages of 30-85. The remaining 15% are mainly ash stands that are 100+ years old. Stands currently listed as “under development” include 94 acres or 76% of the hardwood stands in the 30-85 year old category. Since 2013 the state has harvested 40 acres of aspen, planted 54 acres of red pine and planted 20 acres of lowland black spruce. There has also been 21 acres of conifer enhancement completed within the plot. Past harvest of State lands within this plot has occurred primarily in white pine, red pine, black spruce, and aspen stands.

On SNF lands approximately 41% is aspen and aspen/conifer mix, 33% lowland conifer, 16% spruce fir, and 11% pine. About 20% of the SNF land was harvested approximately 20-30 years ago. The remainder is in a mature and older condition. There has been 12 acres of lowland black spruce and 8 acres of upland aspen harvested both in 2014. Between the years of 1995-2013 St. Louis County harvested approximately 1040 acres in aspen and conifer forest types. Since 2013 St Louis County has harvested approximately 220 acres of upland aspen and planted 55 acres of red pine.

In 2016, 1 moose (corrected estimate = 1) was observed on plot 117, part of the Twin-Mitchell Project Area (Figure 4). Plot 117 ranked below the average of 9.7 and the median of 5.5 moose observed per plot in 2016. For the years 2012-2016, plot 117 has been in the top half of plots for numbers of moose observed 3 times and in the lower half twice.

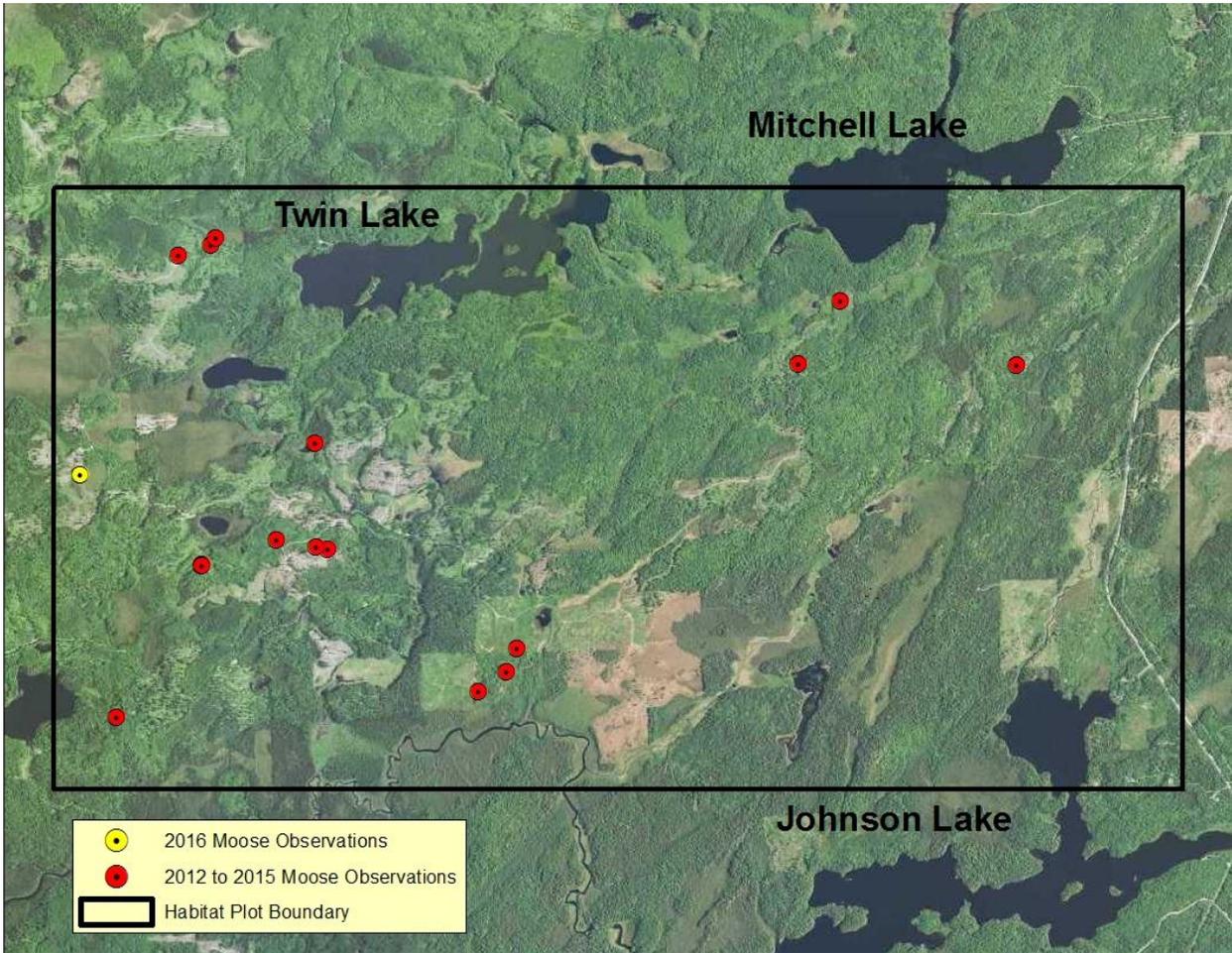


Figure 3. Plot 117, part of the Twin-Mitchell Project Area for timber management.

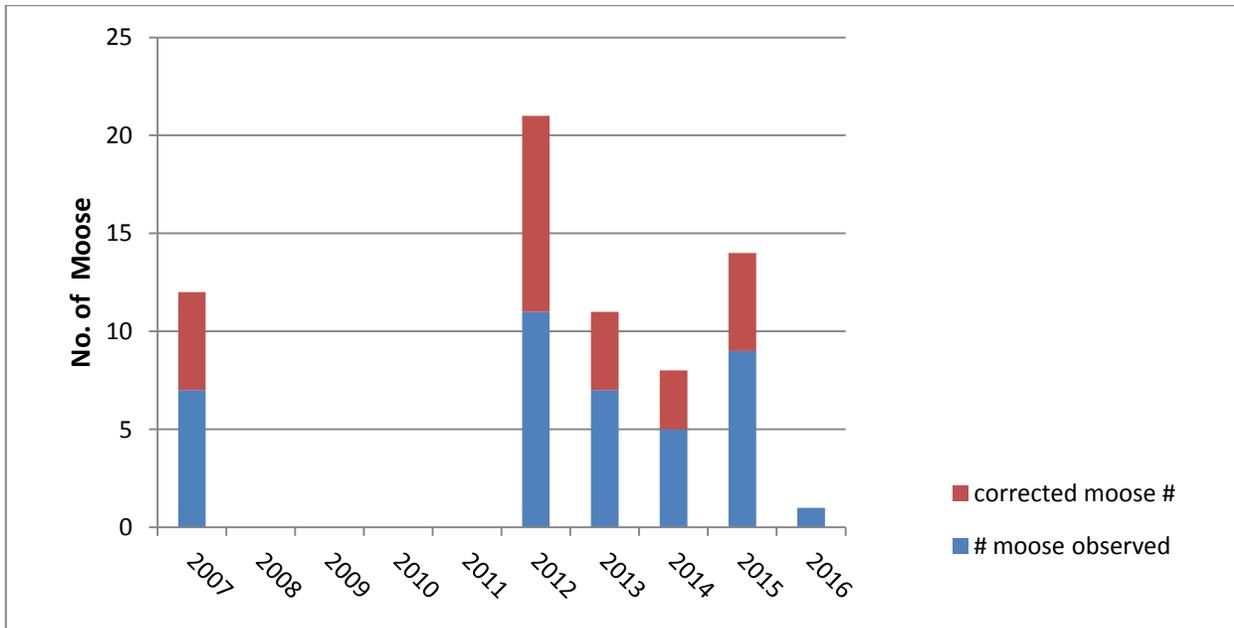


Figure 4. Plot 117 survey results.

Plot 237: Lillian Creek Project Area

Plot 237 is located southwest of Cloquet Lake in Lake County (Figure 5). The plot has mixed ownership; 65% SNF, 15% State, 15% Lake County, and the remaining 5% in private ownership. The plot is about half wetland and half upland habitat. The upland vegetation is dominated by the aspen/spruce-fir cover type. In addition, there are a few acres in stands typed as upland black spruce, jack pine and red pine. Many stands across all ownerships are typed as upland brush. Lowlands are dominated by black spruce, mixed swamp conifer, and lowland brush. The majority of timber (46%) on SNF land and about half the timber on State land is in age classes >70 years of age. On Lake County land 35% of the timber is >70 years of age and 41% is between 20 and 30 years of age.

There has been little recent timber harvest on the plot. Less than 13% of SNF land has been harvested in the last 20 years and an additional 17% of the SNF timber was cut 20-40 years ago. On State land, 8% of the forest has been harvested in the last 20 years, with an additional 19% cut or planted during the 1980s. Lake County has harvested 9% of their land in the last 20 years. The SNF's Whyte Creek Sale was completed in 2013 and 2014. Within plot 237 the sale was even-aged management of 114 acres of aspen/spruce-fir and 76 acres of lowland black spruce. In 2015, 63 acres of upland brush (paper birch, choke and pin cherry hazel, mountain maple, mountain ash and junberry) was cut with brush saws and the area was planted with white pine and white spruce. The State clearcut 3 stands totaling 63 acres of lowland black spruce in 2014.

In 2016, 9 moose (corrected estimate = 15) were observed on plot 237, part of the Lillian Creek Project Area (Figure 6). Plot 237 ranked slightly below the average of 9.7 moose, but above the median of 5.5 moose observed per plot in 2016. For the years 2012-2016, plot 237 has been in the top half of plots for numbers of moose observed 3 times and in the lower half twice.

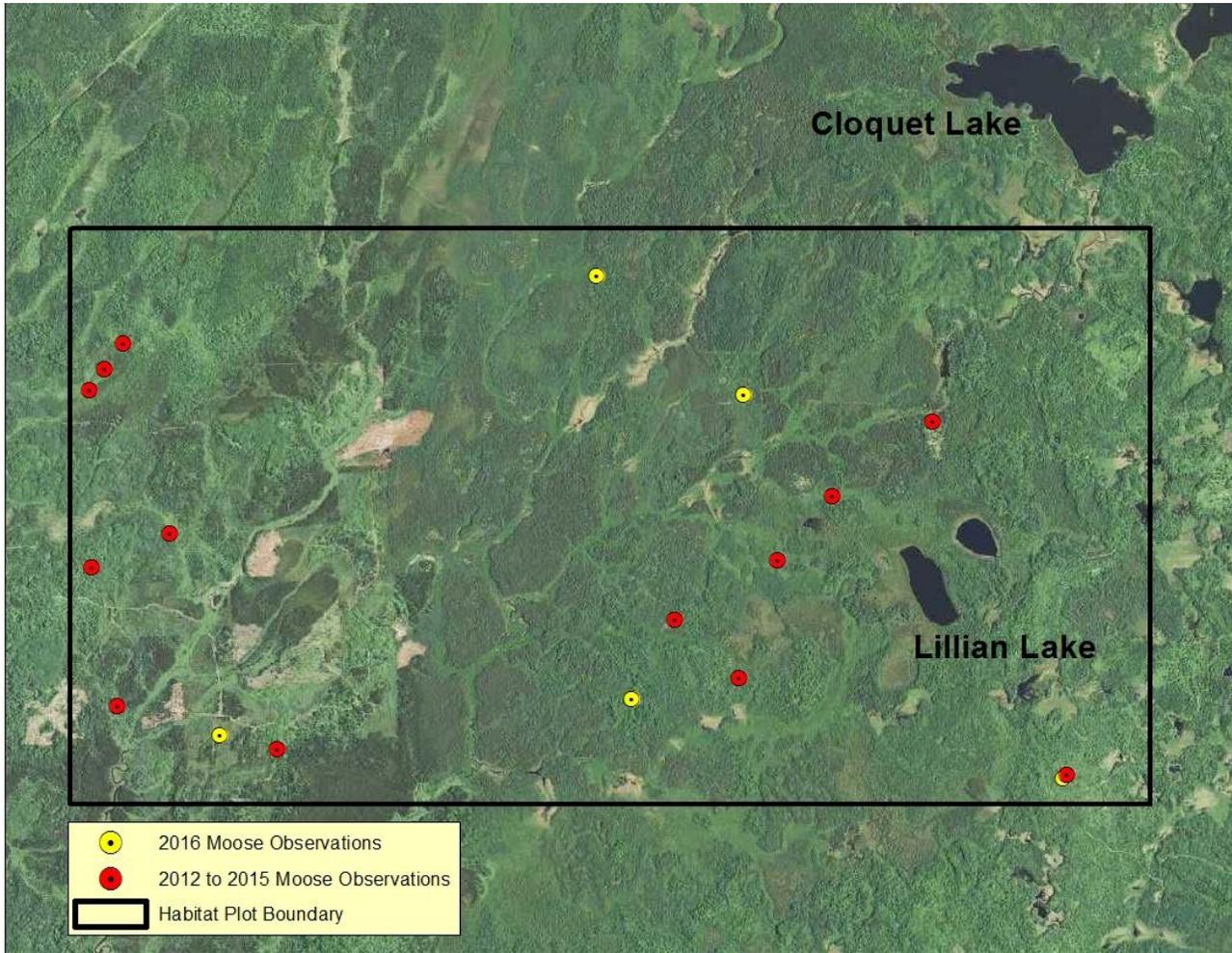


Figure 5. Plot 237, part of the Lillian Creek Project Area for timber management.

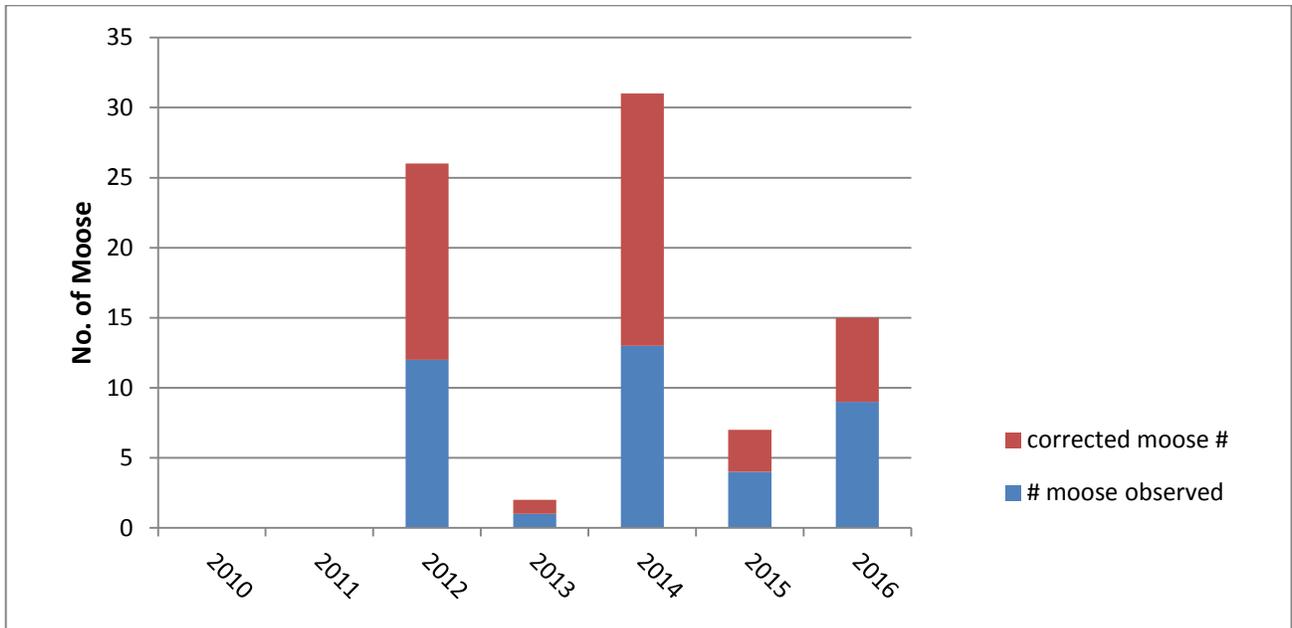


Figure 6. Plot 237 survey results.

Plot 425: Lima Green Project Area

Plot 425 is located immediately southwest of Greenwood Lake in Cook County (Figure 7). Ownership is approximately 85% SNF and 15% State. Within the plot, mesic red and white pine forests comprise approximately 40% and mesic birch-aspen-spruce-fir approximately 37% of SNF lands. Lowland conifer comprises approximately 12% of local SNF land, with cedar, jack pine-black spruce, lowland non-forest and “other” making up the remainder. In 2015, < 1% of the forested cover on SNF land was < 10 years of age. Approximately 40% of the SNF acres are in the 10-49-year age class and 40% are in the 50-99 year age class. The remaining SNF acres are over 100 years old, mostly comprised of mesic red and white pine and lowland conifer forests. State land within plot 425 is 66% in upland forest with aspen-birch and jack pine stands dominating. Black spruce lowland forest is 22% of remaining State land with the rest in non-forest grass, brush or water. About 14% of upland forests on State land are < 10 years old, 22% 11-20 years, and 64% in the 21-160 years old. On State land 57 acres were regenerated to red pine in 2010, 25 acres to aspen in 2012 and 35 acres regenerated to jack pine and black spruce in 2013.

Harvest plans for SNF lands in plot 425 include approximately 2,375 acres of various treatments, including 1,917 acres of clear-cut with reserves. Timber harvest on the Lima Green Project began in April of 2014 and operations are anticipated to continue through 2020. Approximately 136 acres had been harvested at the time of the 2016 survey. There are no current plans for harvest on State land.

In 2016, 17 moose (corrected estimate = 39) were seen on plot 425, part of the Lima Green Project Area (Figure 8). Plot 425 ranked above the average of 9.7 and the median of 5.5 moose observed per plot in 2016. For the period of this habitat survey (2012-2016), and including the 2010 survey, plot 425 has been in the top half of plots for numbers of moose observed every year.

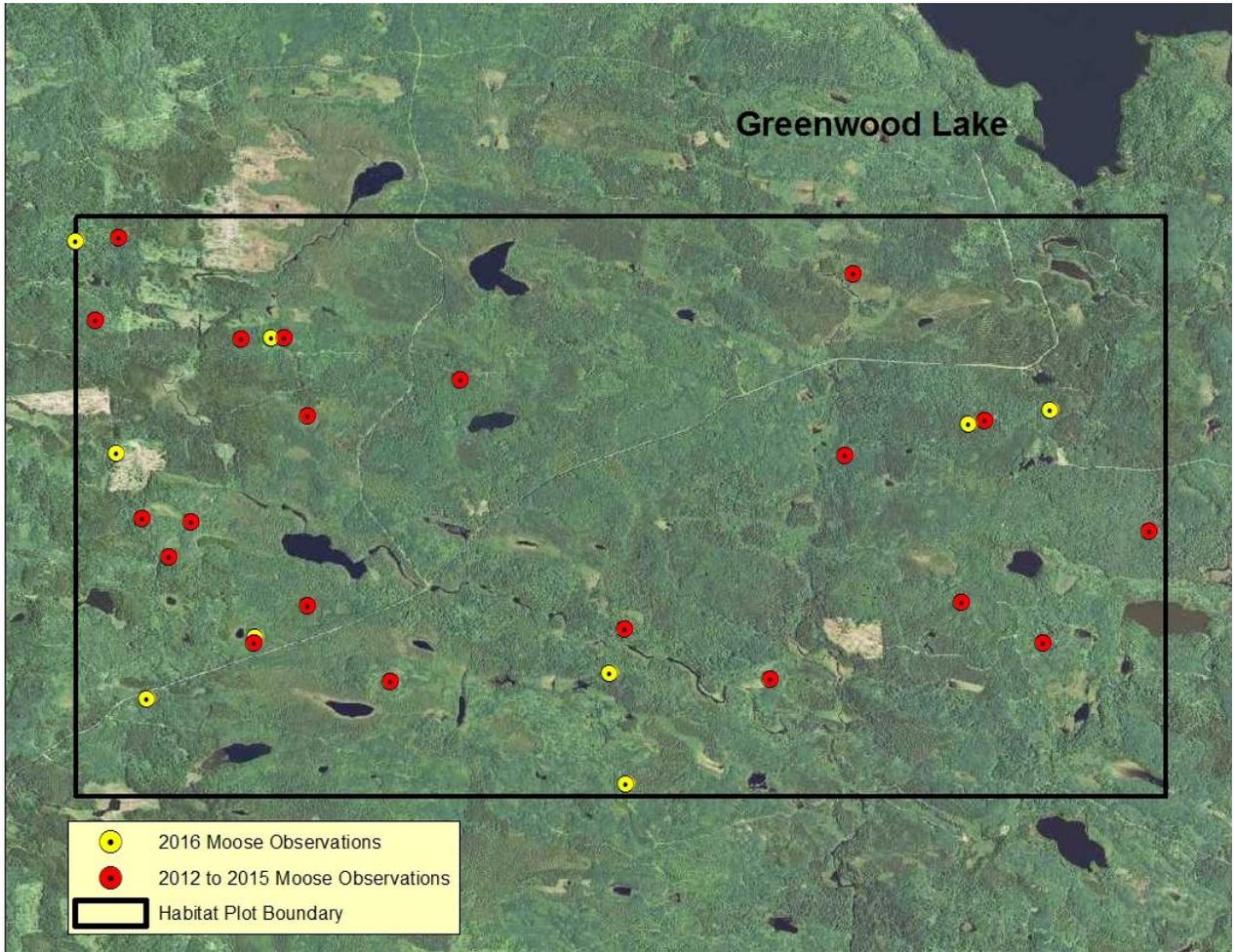


Figure 7. Plot 425 part of the Lima Green Project Area for timber management.

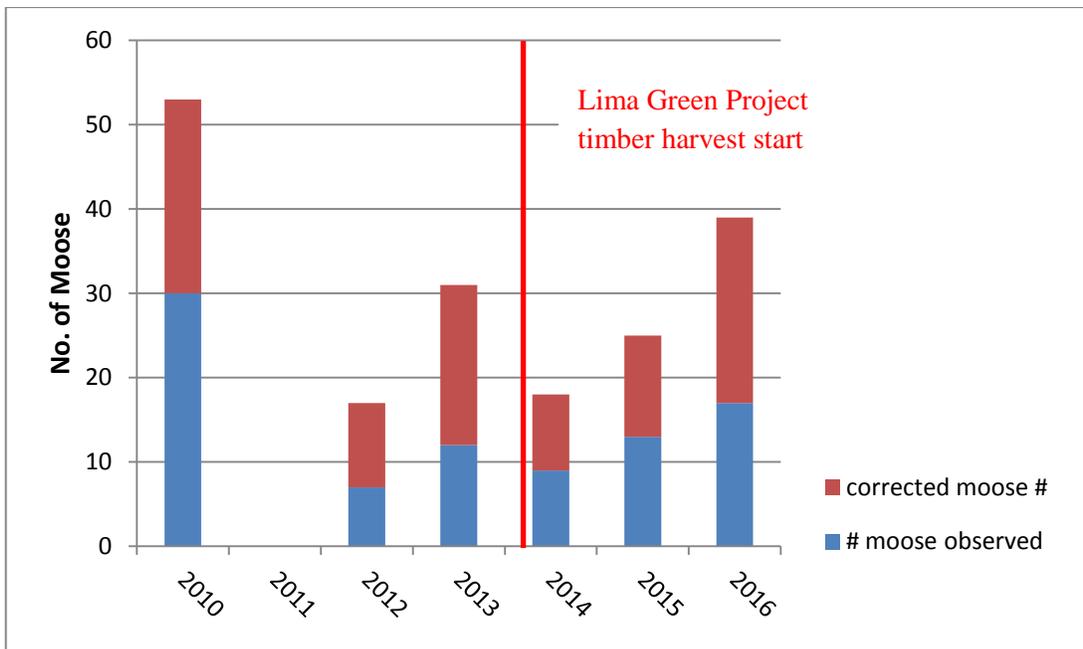


Figure 8. Plot 425 survey results.

Prescribed Fire Plots

Plot 41: Trout Lake Rx Fire

Plot 41 is located on the northeastern shore of Trout Lake in the Boundary Waters Canoe Area Wilderness (BWCAW) in St. Louis County (Figure 9). The Trout Lake Rx Fire was conducted in September, 2005 and totaled 9,867 acres of which approximately 3,860 acres are in the plot. The main purpose of the fire was to reduce fuel loads following the 4 July, 1999 blowdown event. Except for 1,250 acres in the northwest corner of the plot, Plot 41 was entirely impacted by the blowdown with damage increasing in a generally west to east direction. On 1,540 acres, wind damage was estimated at 10-33% of the standing timber. On 4,400 acres across the central and southern portions of the plot wind damage was estimated at 34-66% of the timber. In the northeastern corner of the plot, 1,290 acres suffered damage to 67-100% of the timber.

Almost all moose observations on this plot for the period of this survey (2012-16) and including the 2010 population survey have been within the fire perimeter (Figure 9). Aerial observation suggests fire intensity across the plot was relatively light. Regeneration is a mix of primarily aspen, jack pine, spruce and upland brush across most of the upland portion of the plot. Oak is a prominent component of the regeneration where there are rock outcrops. The plot contains a diverse mix of residual live trees and dead snags resulting in a patchy mix of live and dead post-fire vegetation. Lowland conifer and brush were generally not affected by the Rx fire

In 2016, 16 moose (corrected estimate =27) were seen on plot 41, part of the Trout Lake Rx Fire (Figure 10). Plot 41 ranked above the average of 9.7 and the median of 5.5 moose observed per plot in 2016. For the period of this habitat survey (2012-2016), and including the 2010 survey, plot 41 has been in the top half of plots for numbers of moose observed every year.

Plot 60 directly east of plot 41 was flown in 2016 as well. The perimeter of the Trout Lake Rx Fire encompasses the northwest corner of plot 60. A total of 29 moose were seen in plot 60 and 27 were inside the fire perimeter. Plot 60 was last flown in 2012. In 2012, a total of 17 moose were counted with 8 inside the fire perimeter.

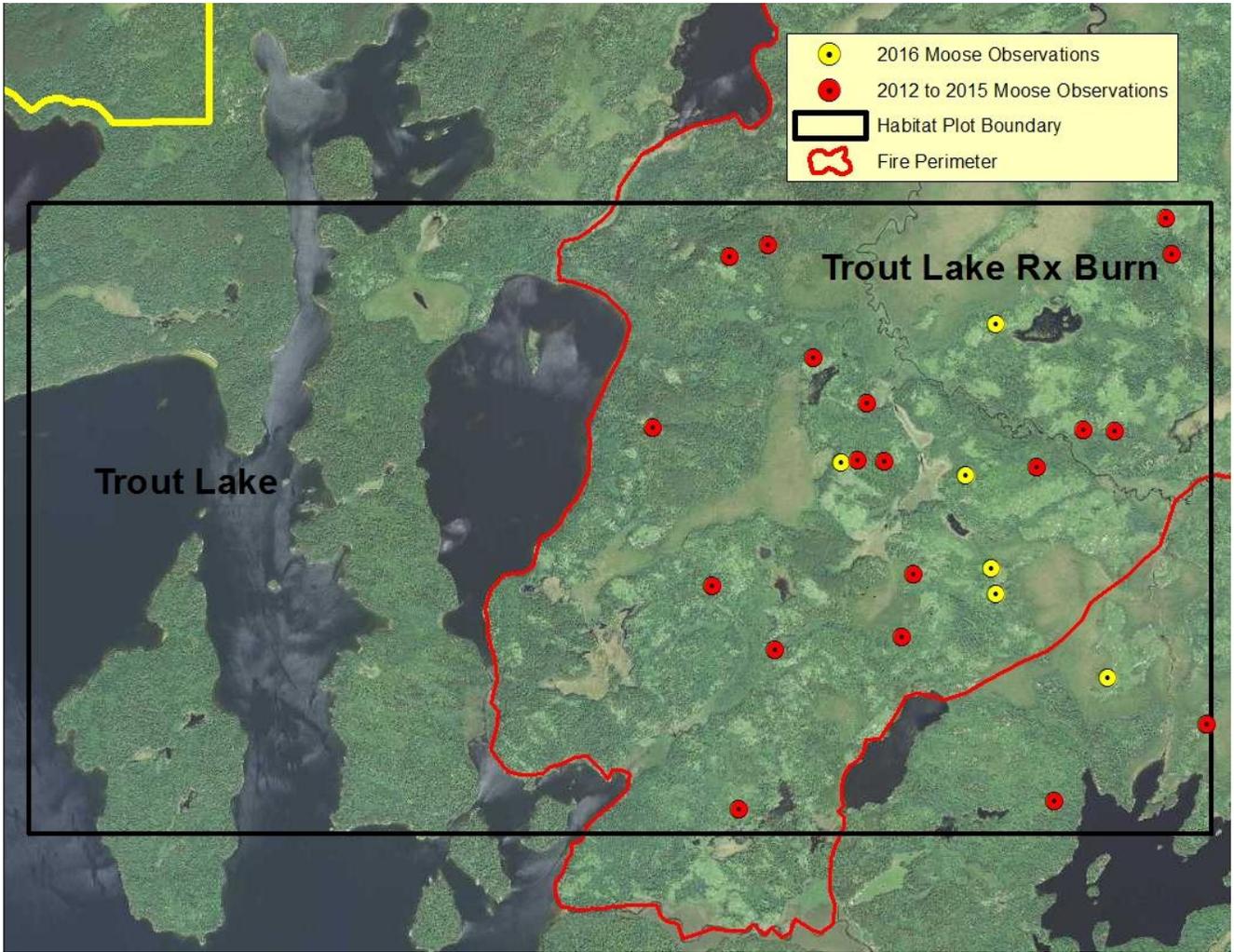


Figure 9. Plot 41 containing part of the 2005 Trout Lake Rx Fire.

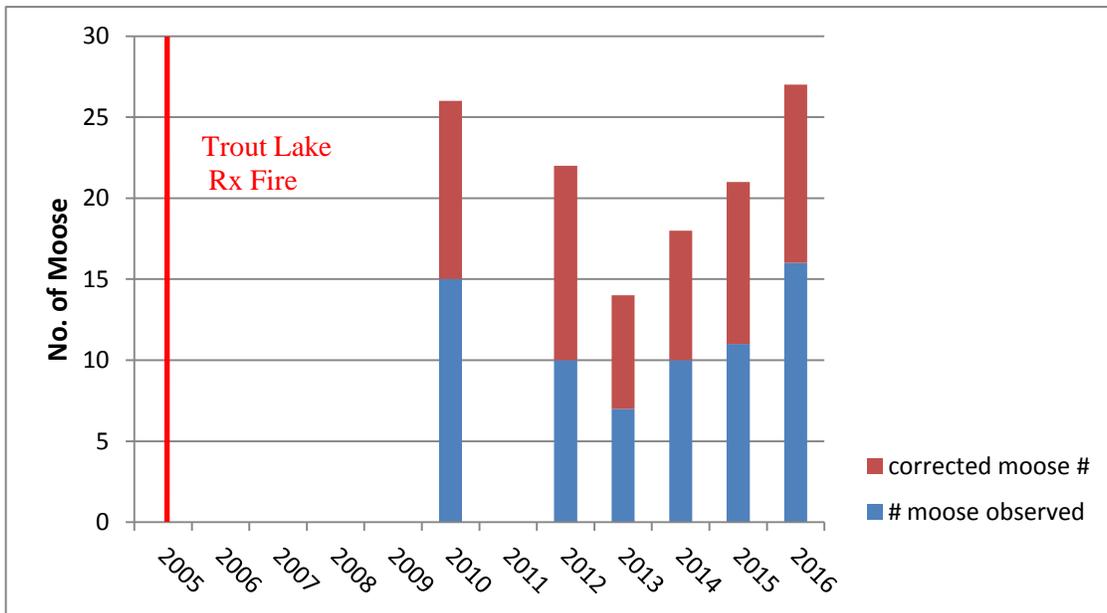


Figure 10. Plot 41 survey results.

Plot 309: Kekspider Rx Fire

Plot 309 is located around Kekekabic Lake in the BWCAW in Lake County (Figure 11). The Kekspider Rx Fire was conducted in October, 2010 and totaled 4,961 acres of which approximately 4,270 acres are in the plot. The main purpose of the burn was to reduce fuel loads following the July, 1999 blowdown event. All of plot 309 was affected by the storm with damage to timber classified as 67-100% across the entire plot.

Since 2012, almost all moose observations on the plot have been within the perimeter of the burn (Figure 11). Aerial observation suggests the fire burned with various intensities across the plot. Regeneration following the blowdown and the fire, is generally well in evidence from the air and contains a strong conifer component. A field visit in 2012 indicated aspen sprouts in burned areas were ≥ 2 feet in some cases (E. Anoszko, University of Minnesota personal communication). The topography of the plot is relatively rugged.

In 2016, 10 moose (corrected estimate = 18) were observed on plot 309, part of the Kekspider Rx Fire (Figure 12). Plot 309 ranked above the average of 9.7 and the median of 5.5 moose observed per plot in 2016. For the years 2012-2016, plot 309 has been in the top half of plots for numbers of moose observed twice and in the lower half 3 times.

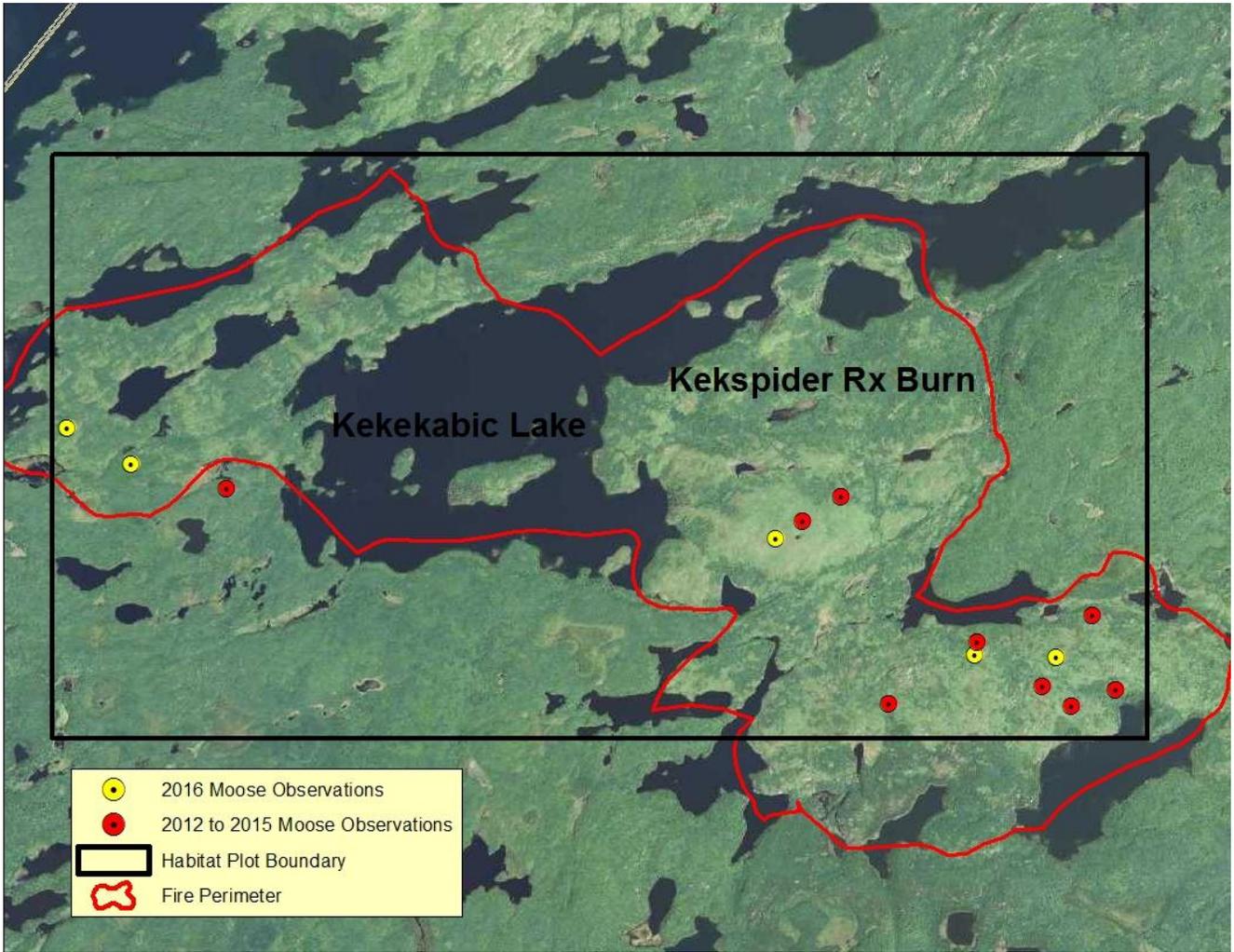


Figure 11. Plot 309 containing most of the Kekspider Rx Fire.

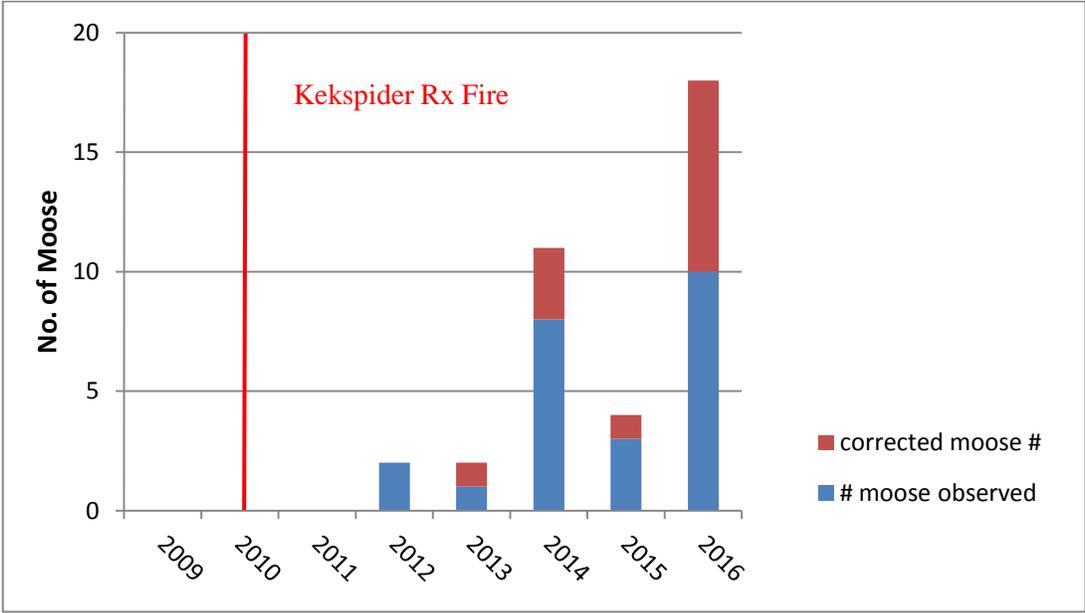


Figure 12. Plot 309 survey results.

Plot 403: Proposed Duncan Lake Rx Fire

Plot 403 is located around Duncan Lake in the BWCAW in Cook County and contains a few acres on the Ontario side of the border (Figure 13). The Duncan Lake Rx Fire is proposed to be 4,780 acres and is planned for completion in the future. Approximately 4,100 acres of the burn would occur in the plot. The main purpose of the burn would be to reduce fuel loads following the July 1999 blowdown event. Wind damage on approximately 4,580 acres on the southern half of the plot is classified as affecting 10-33% of the timber. Wind damage is estimated at 34-66% of the timber on approximately 1,070 acres in the northwest corner of the plot. Approximately 2,840 acres of timber on the northern third of the plot were undamaged by the storm. In addition, approximately 440 acres in the southeastern corner of the plot were burned in the May 1988, Daniel-Bearskin Wildfire. The topography of the plot is relatively rugged.

As indicated above, this plot was relatively moderately damaged by the 1999 blowdown event. Much of the overstory remains intact and includes a mix of hardwood and conifer. Vegetation measurements conducted in 2015 indicated the dominant overstory species was balsam fir and birch and the understory was dominated by dense stands of hazel and mountain maple (C. Maley, 1854 Treaty Authority, personal communication). Where the blowdown was more intense, the forest floor still contains significant large woody debris.

In 2016, 14 moose (corrected estimate = 22) were observed on plot 403, part of the planned Duncan Lake Rx Fire (Figure 14). Plot 403 ranked above the average of 9.7 and the median of 5.5 moose observed per plot in 2016. For the period of this habitat survey (2012-2016), and including the 2011 survey, plot 403 has been in the top half of plots for numbers of moose observed 5 times and in the bottom half once.

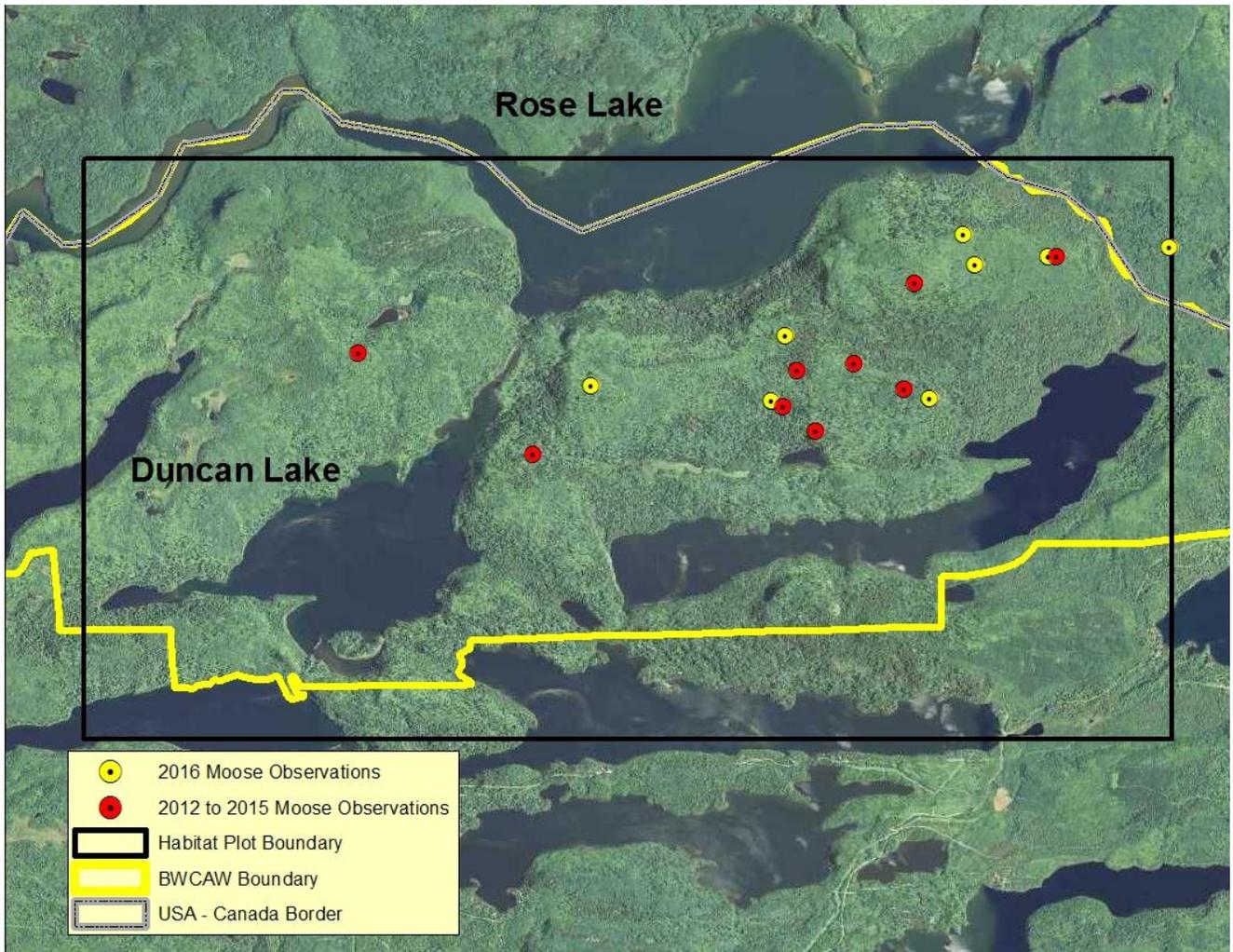


Figure 13. Plot 403, part of the proposed Duncan Lake Rx Fire.

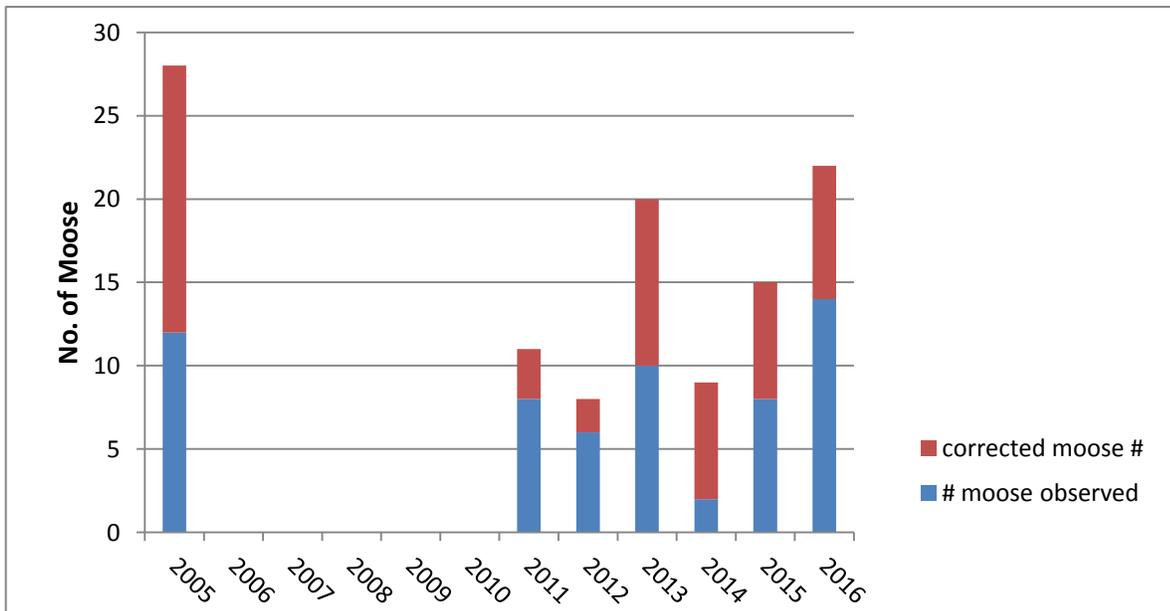


Figure 14. Plot 403 survey results.

Wildfire Plots

Plot 262: Pagami Creek Fire

Plot 262 is located around Quadga Lake in the BWCAW in Lake County (Figure 15). The Pagami Creek Fire was first detected on 18 August, 2011; however, the majority of the fire burned in a single day on 12 September when winds pushed it 16 miles to the east. Fire behavior on that day was particularly extreme. The fire eventually grew to 92,000 acres and “hotspots” remained until winter. Except for approximately 200 acres in the southwestern corner of the plot, the entire plot was affected by the fire. Most of the plot was unaffected by the July 1999 blowdown event. Damage from the blowdown to standing timber was estimated at 10-33% on approximately 250 acres in the northeastern corner of the plot.

Aerial observation suggests the majority of plot 262 was severely burned. While still standing, almost the entire overstory, including many lowland conifer stands, appears to have been killed in the fire. Although probably partly related to lower snow depths in 2015 and 2016 during the survey period, regeneration has now become evident from the air. Vegetation sampling near the southern edge of the plot in 2015 indicated aspen averaging 12 feet in height was most abundant and willow and birch were relatively common. Jackpine averaging 4.5 feet in height was also observed frequently (C. Maley, 1854 Treaty Authority, personal communication).

For the first time since the fire and 2012 when only one moose was observed, 10 moose (corrected estimate = 16) were observed on plot 262 (Figure 16). Plot 262 ranked above the average of 9.7 and the median of 5.5 moose observed per plot in 2016. For the years 2013-2015, no moose were observed on plot 262.

In 2016, 3 other plots overlapping the Pagami Creek perimeter were flown. Plot 303 northwest of Perent Lake had 11 moose within the fire perimeter and 3 outside it, and plot 275 bordering Isabella Lake had a total of 4 moose; all within the fire perimeter. Plot 305 between Insula Lake and Lake Polly had 20 moose within the fire perimeter and 15 outside it in 2016. Plot 305 has been flown twice before since 2010. In the 2011 survey, prior to the fire, there were 21 moose seen on the plot. In 2014, 15 moose were sighted, but only 3 were within the fire perimeter. In addition to survey plots, a number of anecdotal observations of moose were made in 2016 during regular ferry flights across the Pagami Creek Fire to and from survey plots in Cook County. These anecdotal observations had not been noted in previous years since the fire. It will be interesting to see in future surveys if 2016 was the year moose began to respond in a significant way to the habitat changes created by the Pagami Creek Fire.

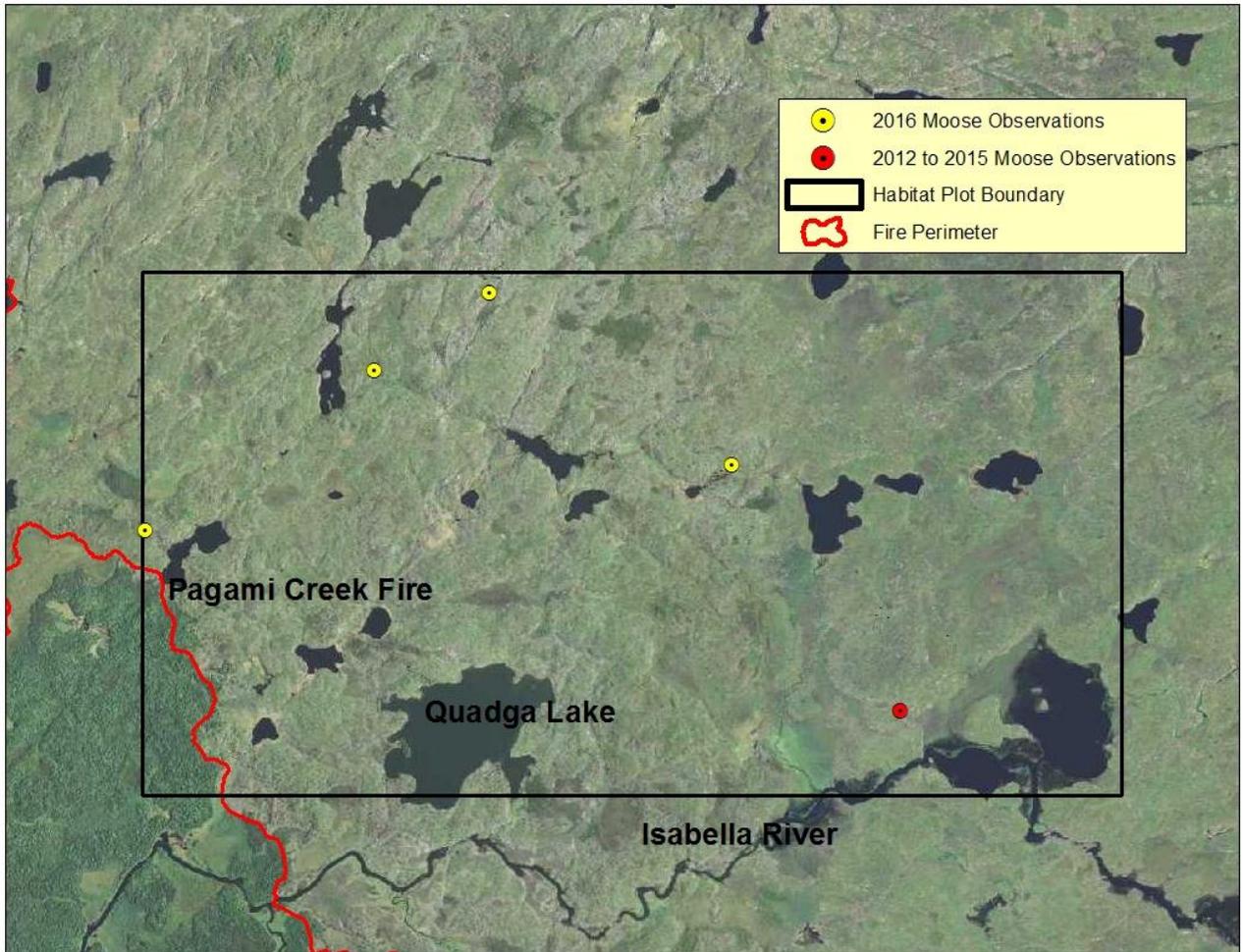


Figure 15. Plot 262, part of the Pagami Creek Fire.

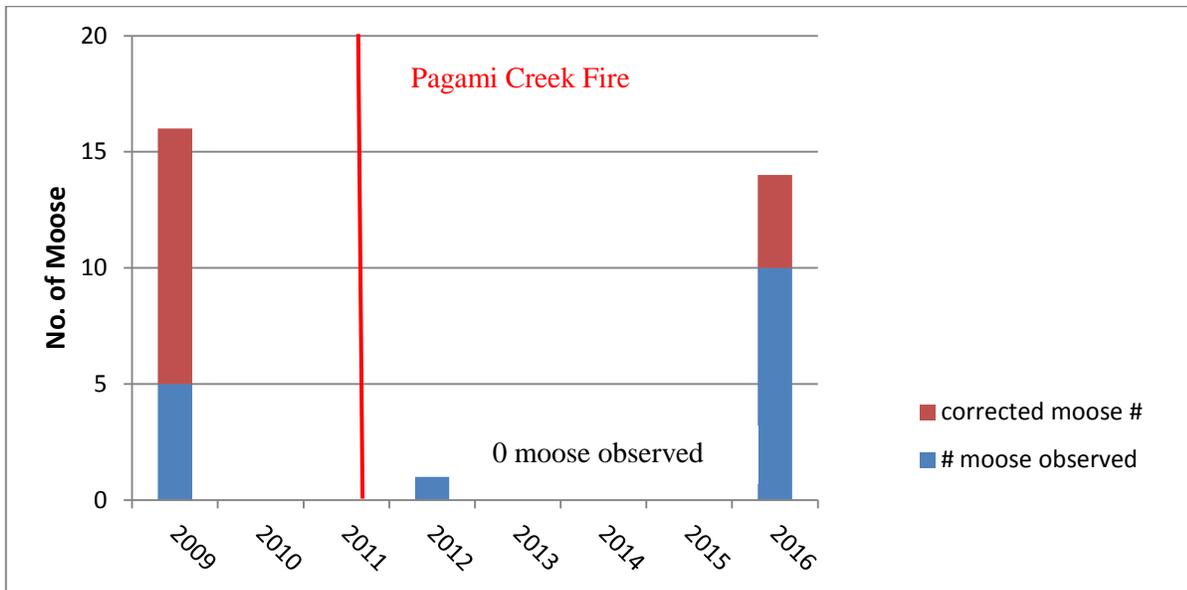


Figure 16. Plot 262 survey results.

Plot 347: Cavity Lake Fire

Plot 347 is located around Sea Gull Lake in the BWCAW in Cook County (Figure 17). Plot 347 was affected by 3 wildfires and a Rx burn between 2002 and 2007, as well as by the July 1999 blowdown event. The Cavity Lake Fire ignited on 13 July, 2006 and remained active until the middle of August, burning an estimated 31,830 acres total and 6,210 acres in the plot. The August, 2005 Alpine Lake Fire burned 1,070 acres in the north-central part of the plot and the Ham Lake Fire burned 110 acres in the very southeastern corner of the plot. On the southern end of Threemile Island, 140 acres within the plot were burned in a September, 2002 Rx fire. In addition to the fires, the entire plot was impacted by the July, 1999 blowdown. Damage to timber was estimated at 67-100% on approximately 3,500 acres in western and southern portions of the plot and at 34-66% on 4,500 acres in the central and northern portions. Remaining timber in the northeast suffered damage estimated at 10-33%. Surviving overstory was primarily balsam fir, red maple, birch, cedar, black spruce and jack pine (E. Anoszko, University of Minnesota, personal communication).

The southern part of plot 347 appears to have been burned more severely in the Cavity Lake Fire than the northern half of the plot. While regenerating brush is evident from the air, much of the upland overstory was removed in the southern half of the plot. In the northern half of the plot, the Alpine Lake Fire and the northwest corner of the plot in the Cavity Lake Fire appear to have been burned less severely, and scattered individual and groups of overstory trees remain alive. Vegetation plots in moose plot 347 (n=318) established from 2011-2012 show regeneration dominated by birch (28% of stems) and aspen (26%) with lesser amounts of beaked hazel (11%) and other species (<5% each). At the time regeneration was sparse (<50% coverage) and generally <6 feet tall (E. Anoszko, University of Minnesota, personal communication). Vegetation sampling in 2013 and 2014 in plot 347 and elsewhere in the Cavity Lake Fire produced similar results (C. Maley, 1854 Treaty Authority, personal communication). Scattered young white spruce, jack pine, and white pine were also noted in 2016 (personal observation).

In 2016, 31 moose (corrected estimate = 51) were observed on plot 347 (Figure 18). Since 2012, plot 347 has consistently ranked among the top 4 out of 49-52 survey plots for numbers of moose observed. In 2016 it ranked 4th, well above the average of 9.7 and the median of 5.5 moose.

Since this survey started in 2012, and including the 2007 and 2010 population surveys, no moose have been observed on the portion of the 2002 Rx fire on Three Mile Island in plot 347.

In addition to plot 347, plot 345 on the south side of the Cavity Lake Fire between Gillis and Gabimichigami Lakes was flown in 2016 as well. Only two moose were observed there, both inside the fire perimeter.

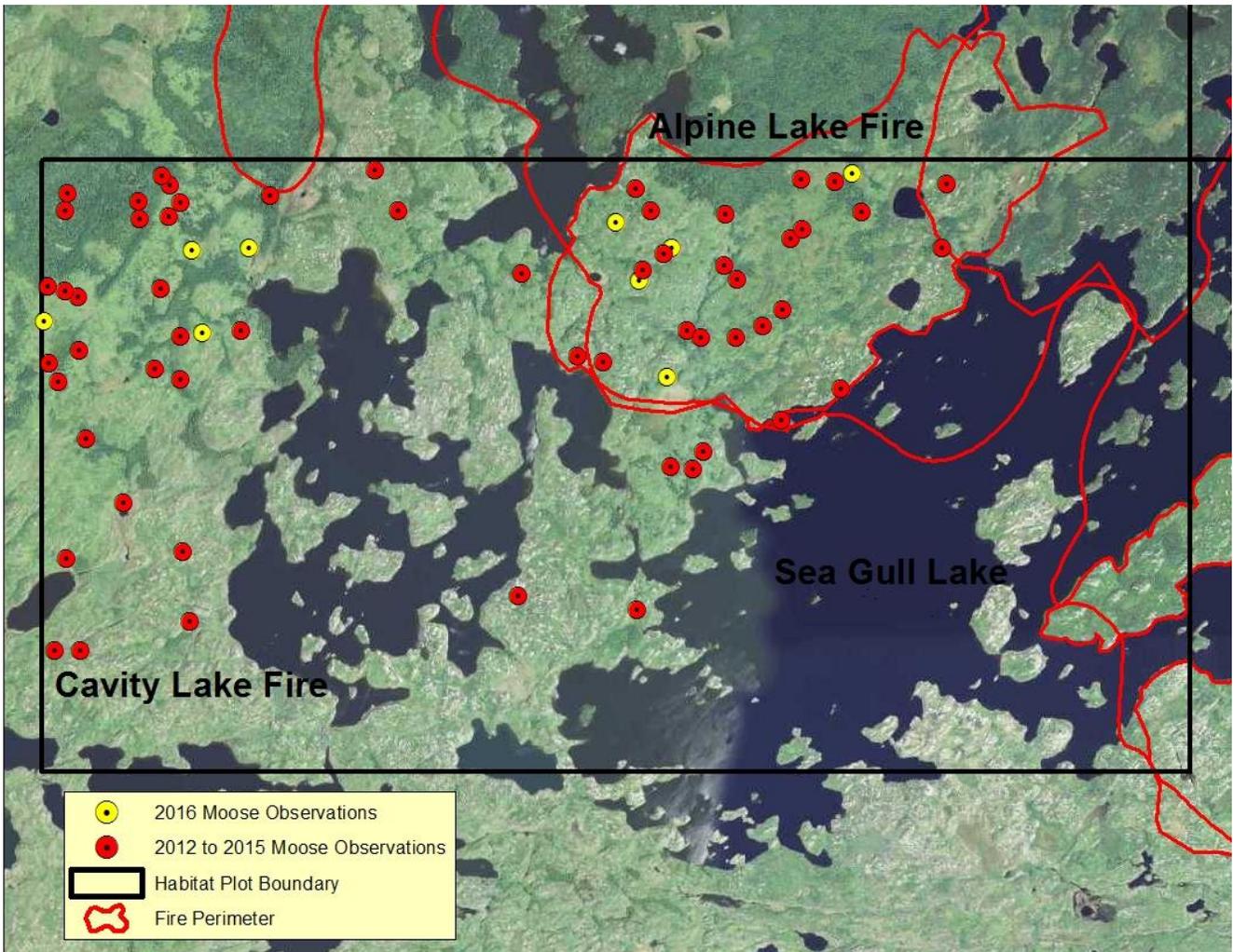


Figure 17. Plot 347, part of the Cavity Lake and Alpine Lake Fires.

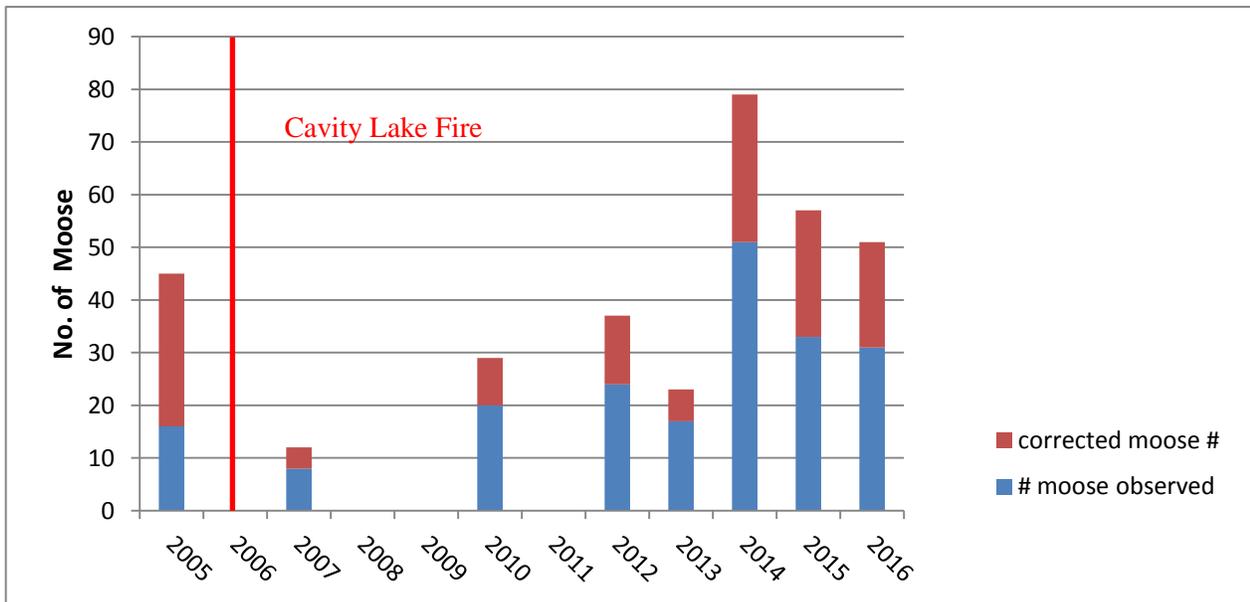


Figure 18. Plot 347 survey results.

Plot 350 Ham Lake Fire

Plot 350 is located at the end of the Gunflint Trail in Cook County, partially in and out of the BWCAW with some acres in Ontario as well (Figure 19). The Ham Lake Fire started on 5 May, 2007, and eventually burned over 75,000 acres in Minnesota and Ontario. Approximately 6,480 acres on the eastern two-thirds of the plot were affected by this fire. In addition, approximately 1,160 acres along the western edge of the plot were burned in the August, 1976 Roy Lake Fire. In addition to the fires, the July, 1999 blowdown affected much of the plot as well. Timber damage estimated at 10-33% occurred on approximately 4,000 acres in the western and southern portions of the plot. Approximately 3,470 acres in the central and eastern portions of the plot suffered damage estimated at 34-66%, and an additional 640 acres in the east central area suffered damage estimated at 67-100% of the timber. The south central part of the plot is well developed with roads, cabins and campgrounds associated with the Gunflint Trail corridor.

Aerial observation suggests the eastern 2/3rds of the plot which burned in the Ham Lake Fire, has abundant brush regeneration. Many of the conifer swamps in the fire's perimeter appear to have retained their canopy and provide an interspersed cover with the burned areas. Vegetation plots in the Ham Lake Fire portion of plot 350 (n=49) from 2011-12 show thick and well established brush regeneration (>50% coverage) and >6 feet tall. Aspen was 20% of the regenerating stems followed by hazel (14%), jack pine, (12%) alder (12%), mountain maple (11%), birch (9%), pin cherry (8%) and 5% willow species (E. Anoszko, University of Minnesota, personal communication). The western 1/3rd of the plot burned in the Roy Lake Fire is covered with dense, primarily jack pine, regeneration. Vegetation plots in the Roy Lake Fire portion of plot 350 (n=20) show few shrubs or other species present (E. Anoszko, University of Minnesota, personal communication). Additional vegetation sampling in the plot in 2013 and 2014 showed 23% birch, 20% aspen and 20% willow with 9% beaked hazel and 9% pin cherry (C. Maley, 1854 Treaty Authority, personal communication).

In 2016, 36 moose (corrected estimate = 52) were observed on plot 350, part of the Ham Lake Fire (Figure 20). Since 2013, plot 350 has consistently ranked in the top 10 out of 49-52 survey plots for numbers of moose observed. In 2012 it was in the top 12 of 49 plots. In 2016 with 36 moose observed, it had the 2nd highest plot total; well above the average of 9.7 and the median of 5.5 moose observed.

In 2016, plot 351 immediately south of plot 350 was flown as well. Except for some small unburned islands on Seagull Lake and the prescribed fire encompassing Threemile Island, all of plot 351 is in the Ham Lake perimeter. A total of 22 moose were seen on plot 351; 20 within the Ham Lake perimeter and 2 within the Threemile Island perimeter.

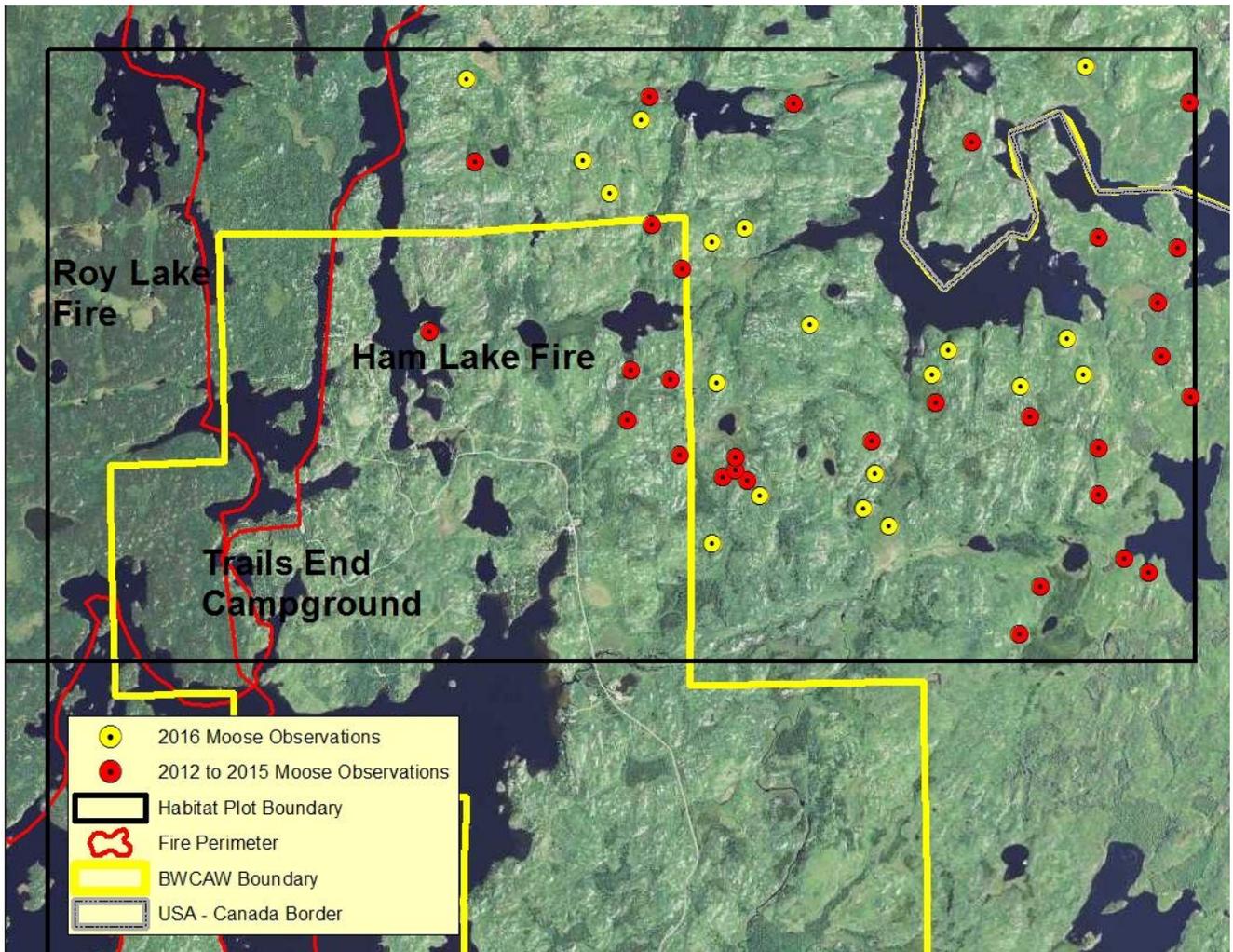


Figure 19. Plot 350, part of the Ham Lake Fire.

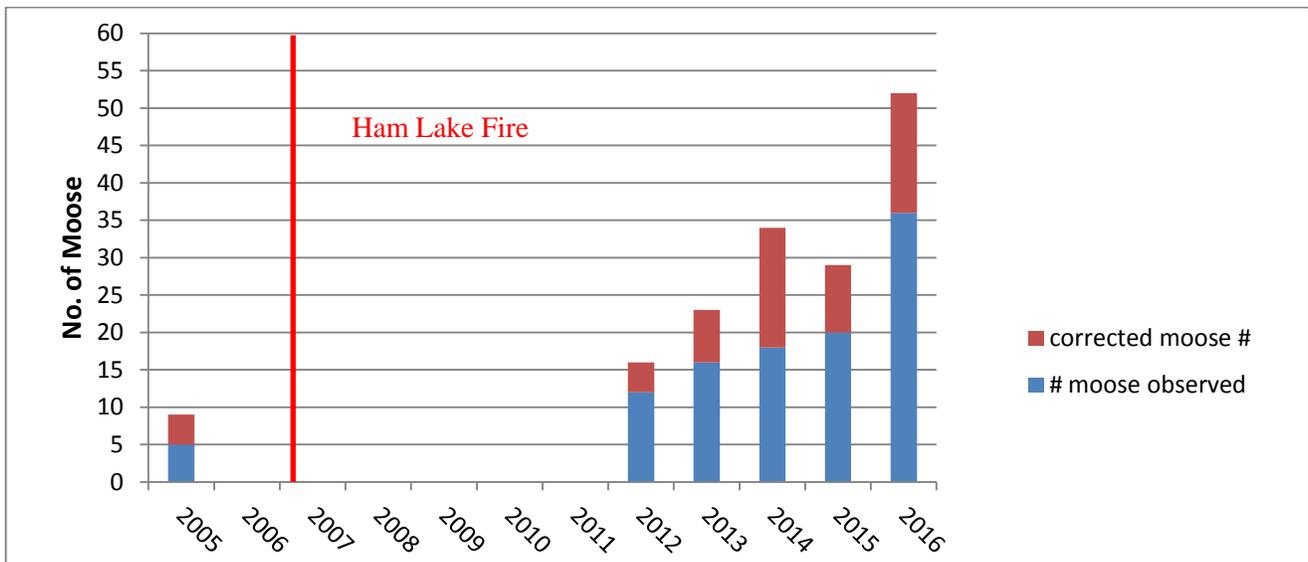


Figure 20. Plot 350 survey results.

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Figure 21. A cow and twin calves in the Pagami Creek Fire.

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