EFFECTIVENESS OF MITIGATION MEASURES ON MOOSE VEHICLE COLLISIONS

By

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Abstract

This study analyzed the statistical significance of continuous lighting and/or clearing and grubbing of roadway corridors as measures taken to reduce moose-vehicle collisions (MVCs). Construction improvements, moose population, and weather data were collected for ten project corridors. Data were gathered for a 10-year period for each project, spanning from 5 years before to 5 years after the construction completion date. To determine the statistical significance of the variables, regression analysis was performed for every possible combination of variables.

The results of the regression analyses showed different levels of variation in crashes being explained by the data set. The results for four of the projects were inconclusive; therefore, a correlation between the number of reported MVCs and the independent variables could not be determined. The results from the other projects show between 22.0% and 85.9% of the variation in collisions being explained by the independent variables, with differing results on which variables contributed to the number of MVCs. Among the projects, differences in whether the variable contributes to an increase or decrease in the number of MVCs are apparent. These results show that the variables do not capture all the contributing factors related to MVCs.

A combined set of all project corridors was evaluated. The combined set regression analysis resulted in only 12.0% of the variation in collisions being explained by the independent variables. This result also shows that more factors contribute to MVCs than were included as variables in this study.

Although this study resulted in low statistical significance, there is evidence of positive results for the mitigation measures, continuous lighting and clearing and grubbing. Continued monitoring of post construction conditions, Maintenance and Operations events, and data collection for continued improvements will increase the accuracy of the data for future re-analysis and the development of crash modification factors.

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Dedication

To my family, for all their love and support.

Chapter 1 Introduction

The State of Alaska Department of Transportation and Public Facilities (DOT&PF) has used continuous lighting and/or clearing and grubbing of several corridors in the past two decades with apparent, but unquantified, success at reducing moose-vehicle collisions (MVCs). These measures, which pose less of a barrier to moose movement than fencing, are used more often in corridors where adjacent land access precludes fencing systems. However, very few in-depth analyses have been conducted to document the correlation between clearing and lighting and the effects of these measures on MVCs. To analyze the effects of past efforts, it was important to accumulate project examples with 3 to 5 years of reportable crash data after project completion.

The MVC problem has been mainly reported on rural highways surrounding major cities and towns, primarily near Anchorage, Palmer, Wasilla, Soldotna, Kenai, Fairbanks, and North Pole. With large numbers of Alaskans living in proximity to significant moose populations, transportation of people and goods poses challenges that increase risks to both humans and moose.

Table 1 shows the average number of moose–vehicle collisions on an annual basis in Alaska—over 800 MVCs every year (ADF&G, 2017). This rate is one of the highest in the world for this type of animal (Thomas, 1995). A vehicle that collides with a moose has the potential to cause significant injury or death to vehicle occupants. About 1.5% of all MVCs result in serious injuries to vehicle occupants, and 0.25% results in fatalities. The average cost per moose collision is about $35,000 in vehicle damage and collision response (DOT&PF, 2014). Moose-vehicle collisions increase the risk of injury and damage to humans and moose as well as property.

Table 1. Average Number of Moose-Vehicle Collisions by Region

Region	Average Number of Moose-Vehicle Collisions
Kenai Peninsula	250
Municipality of Anchorage	120
Mat-Su Valley	280
Fairbanks Area	126

Data taken from ADF&G Give Moose a Brake website (ADF&G, 2017).

The objective of this study was to investigate the statistical significance of continuous lighting and/or clearing and grubbing of roadway corridors as measures taken to reduce MVCs. Many studies have been performed to evaluate the effectiveness of mitigation measures on ungulates such as deer, but there has not been a project that evaluated the effectiveness with respect to moose related accidents. These studies have been in locations where MVCs are less common than other wildlife collisions, so moose were not the main focus (see Chapter 2). Alaska has a much higher rate of MVCs and the DOT&PF has been focusing on mitigation measures specific for moose for a long time.

This study documented the apparent crash mitigation effects of highway lighting and clearing in reducing/preventing MVCs. The results are of value, as moose are difficult to see at night because of their dark bodies, which do not reflect light or because they blend into vegetation along the roadway (see Figure 1). Unlike deer, moose seldom look directly at on-coming vehicles, so no eye-shine reflection of headlights can be observed. This study also reviewed the differences in the two mitigation measures for continued use in Alaska, as they are not routinely accepted for ungulates such as deer and elk. Based on the results of studies reviewed, better illumination and clearing methods have been suggested, but further analysis is required.

Figure 1. Moose Eating Vegetation alongside Roadway

A literature review of other studies on MVCs was conducted. The literature review was followed by data collection related to the project corridors, information provided by DOT&PF, and additional characteristics considered influential in MVCs. The data were assembled for each corridor and analyzed to determine each variable's statistical significance in MVCs.

Chapter 2 Literature Review

The literature reviewed included published research, reports, and articles relevant to the project. Journal databases accessed for articles on animal-vehicle collisions, specifically MVCs, were Alces, Biological Conservation, International Journal of Geographical Information Science, Journal of Applied Ecology, Journal of Environmental Management, Journal of Safety Research, The Journal of Wildlife Management, Landscape and Urban Planning, Society for Conservation Biology, and Wildlife Society Bulletin.

Also reviewed were publications by DOT&PF, publications from the Alaska Department of Fish and Game (ADF&G), Highway Safety Information System, and other national and international organizations interested in highway and traffic safety.

The literature review focused on the following issues related to clearing and lighting:

- Identification of moose activity patterns
- Identification of moose migration patterns
- Determination of factors that influence moose behavior
- Identification of methodologies for establishing statistical relationships between MVCs and various environmental factors
- Identification of MVC mitigation measures
- Effectiveness of mitigation measures
- Management implications

2.1 Moose Behavior

Testa et al. (2000) studied the daily movements of parturient female moose from 1994 to 1997 in southcentral Alaska and found that movements increased significantly in the 2 days prior to parturition and decreased for at least 9 days post-parturition. They also found that levels of pre-parturition movement were not resumed until the calf reached about 26 days old. The study revealed that the daily movements of females that eventually lost a calf exceeded the movements of females with surviving calves by 12%. Distances between birth sites in successive years were greater among females that lost their calves the first year, regardless of age at which the calf died, which suggests that female moose return to successful birth site areas (Testa, Becker, & Lee, 2000).

In a study reported in the article "Winter-Range Philopatry of Seasonally Migratory Moose" (Sweanor & Sandegren, 1989), a seasonally migratory population of moose was monitored in central Sweden to study the winter-range distribution of individual nonbreeding moose in areas with differing population density, snow conditions, and forest damage. The authors found the following:

- The average winter range is 11.5 km^2 (4.44 mi^2), with no difference between age or gender.
- Winter home-range size is affected by long durations of snow > 70 cm (27.6 in.) deep, but not by snow depths of 25 or 40 cm (9.8 or 15.7 in.). Moose begin fall migration on different dates in different years, and duration varies from year to year, although size or range does not differ.
- Consecutive winter ranges have mean midpoint separation distances less than the approximate diameter of the average winter home range, but there are no differences between nonconsecutive winter ranges, indicating that moose do not disperse gradually.

In a case study of fine-scale movements of moose, Leblond et al. (2010) found that moose movement differs between sexes and within daily and annual periods. Their study, as reported in the article "What Drives Fine-Scale Movements of Large Herbivores? A Case Study Using Moose," revealed that moose select steeper uphill slopes and avoid downhill slopes during late winter, and select gentle slopes and intermediate elevation variation from spring to early winter.

In the article "Linking Moose Habitat Selection to Limiting Factors," Dussault et al (2005a) discuss their investigation of moose habitat selection, where the main factors limiting moose numbers were likely predation risk, food availability, and snow. They used GPS telemetry to track moose in the Jacques Cartier Park and part of the adjacent Laurentides Wildlife Reserve in Quebec, Canada. The researchers found that, at the landscape scale, moose segregate themselves from predators by avoiding areas that receive the lowest snowfall, but moose also establish home ranges in areas of shelter from snow, bordered by habitat providing abundant food. At the home-range scale, moose display a preference for food abundance, but not protection from predation or snow. The researchers also found that female moose with calves had a higher preference for areas providing protection from predation, whereas solitary moose prefer areas providing moderate food abundance, moderate protection from predation, and substantial shelter from deep snow).

In their article "Space Use of Moose in Relation to Food Availability," Dussault et al. (2005b) assessed the influence of temporal and spatial changes in food availability on home-range size and movements of moose. They found that home-range size is 42.1 km^2 (16.3 mi^2) in summer and 6.4 km^2 (2.5 mi^2) in winter, regardless of sex. Though home-range size is larger in summer than in winter, the seasonal difference is greater for females than males. Movement rates of moose are twice as high in summer than in winter, and as with home-range size, the seasonal difference is more pronounced for females than for males. The researchers found the following in relation to food availability:

- In summer, moose movement rates are lower in deciduous and fir than in spruce and other habitat types.
- In winter, movement rates are lowest in fir than in spruce and other habitat types.

In a study of seasonal activity patterns of moose, Bevins et al. (1990) obtained monthly estimates of 24-hour activity patterns of moose on the Kenai Peninsula, Alaska, during winter and summer. They found the following:

- Mean time spent active in a 24-hour period during a winter month ranges from 349 to 587 minutes and during a summer month ranges from 427–838 minutes, which shows that moose are significantly more active in summer than in winter.
- Shorter resting periods during summer months compared with winter months, resulting in increased activity from winter to summer.
- No difference in active period length between summer and winter (80 and 81 minutes, respectively).

Del Frate and Spraker (1991) used collected information from moose-vehicle collisions (MVCs) on the Kenai Peninsula, Alaska, to assess roadkills and initiate a public awareness program that potentially would reduce moose roadkills. Their analysis revealed that improved winter road maintenance and the severe winter of 1989–90 led to a significant increase in roadkills.

In the article "Activity Patterns of Predator and Prey: A Simultaneous Study of GPS-Collared Wolves and Moose," Eriksen et al. (2011) summarized their study of the simultaneous activity of a breeding wolf pair and five adult moose cows from April to November 2004 in southeastern Norway. They found that moose activity generally peaks at dusk, whereas wolf activity peaks at dawn. Travel speed varies significantly between species and months. The distance that wolves travel per time unit is highest in September and lowest in June; for moose, the highest is in May and August. The results of the study did not support the hypothesis that moose have adopted an activity pattern asynchronous with that of wolves in order to avoid them.

According to the summary report by the Highway Safety Information System (1995) "Investigation of Crashes with Animals," the greatest number of animal collisions occurs during the early morning hours (4:00 to 6:00 a.m.) and during the evening hours of 6:00 to 11:00 p.m.. Based on the five Highway Safety Information System statistics used in the study, 66% of all reported animal collisions occurs on two-lane rural roads, and animal crashes are more frequent at night with occurrences ranging from 68% to 85%.

In the article, "Activity Patterns in Moose and Roe Deer in a North Boreal Forest," Cederlund (1989) (1989)reported that roe deer differ from moose in having activity bouts more evenly distributed over the day. In this study, conducted in a north boreal forest in central Sweden, the following was determined:

- Generally, both species are most active during sunrise and sunset, showing an evident biphasic pattern in late autumn.
- Average length of active bouts does not differ significantly between the species, but changes with season.
- Low activity level in winter and early spring indicates conservation of energy, when animals make use of patches with relatively dense but low-quality forage.
- In summer, emphasis shifts toward high-quality plants. More browsing and activity increase.

2.2 Establishing Methodologies

In the article "Utility of Expert-Based Knowledge for Predicting Wildlife-Vehicle Collisions" (Hurley, Rapaport, & Johnson, 2009), an Analytical Hierarchy Process (AHP) was used to better understand why and where wildlife-vehicle collisions occur. Using the AHP, expert-based models were developed to test the hypothesis that collisions are either a product of habitat- or driver-related factors. Spatially overlaid expert-based weightings for all criteria were used to provide a quantitative prediction of MVC risk across the study area, and it was found that, overall, habitat-based models are more proficient than driver-based models in predicting MVCs. The data from this study suggest that MVCs and highway attractants related to habitat are strongly related, indicating that MVCs can be reduced through vegetation management or alternative routing.

Hurley et al. (2007) used six subsets of logistic regression models and Akaike's Information Criteria (AIC) to determine the best matched model within each subset. In their study published in the article "A Spatial Analysis of Moose-Vehicle Collisions in Mount Revelstoke and Glacier National Parks," five of the six subsets modeled local-scale/field-based hypotheses, while the sixth examined landscape-scale hypotheses with the use of a Geographic Information System (GIS). The six subsets included driver visibility, moose evidence, highway design, roadside vegetation, moose habitat, and landscape/GIS. The driver visibility model showed a significant relationship between speed and MVCs. In the GIS model, the landscape slope variable was observed to have a negative influence on MVC probability, indicating that moose prefer to cross on a relatively flat slope. Distance to wetland showed high correlation with MVCs, and distance to water showed low correlation with MVCs. Low prediction ability was found between roadside vegetation and MVCs, which can be attributed to the uniform corridor throughout the study area. The landscape-scale/GIS model approach shows promise in assessing contributing variables within the process of determining where MVCs occur.

An adapted kernel density estimator and Ripley's *K*-function was used to test the hypothesis that MVC clustering occurs at multiple scales in space, in time, and in space-time combined as reported in "Multi-scale Spatiotemporal Analyses of Moose-Vehicle Collisions: A Case Study in Northern Vermont" (Mountrakis & Gunson, 2009). This exploratory and multi-scale statistical analysis proved effective in displaying varying and similar spatiotemporal patterns on roads. The kernel estimation generates comparable distribution maps of density. Ripley's *K*-function or reduced second moment function measures spatial dependence or clustering of events at multiple scales. The researchers noted that the analyses were based on recorded incidents and did not include unreported cases or when animals die away from the road.

Simple logistic regression analyses were used in predicting locations of MVCs in Sweden (Seiler, 2005). The data in Seiler's study, "Predicting Locations of Moose Vehicle Collisions in Sweden," included the spatial distribution of moose-vehicle collisions reported to the police in two regions with similar habitat conditions, moose populations, and road networks. Additional data for the two study areas were collected; they included landscape, road and traffic, MVCs, and moose abundance and harvest. Multiple logistic regression analyses were used to identify 25 different road traffic and landscape parameters that are assumed to influence MVCs. Unpaired *t*-tests and univariate logistic regression models were used to identify variables that significantly differed between accident sites and control sites. The variables were then grouped into three priori models: road-traffic model, landscape model, and a combined model. The results of this study showed that simple logistic regression analyses give strong support for the combined model.

2.3 Mitigation Measures

In an article "Difference in Spatiotemporal Patterns of Wildlife Road-Crossings and Wildlife-Vehicle Collisions," Neumann et al. (2012) reported that moose show a bimodal activity pattern with a strong seasonal pattern. Moose are most active in the morning and afternoon for about 3 hours. In addition to determining daily peak movements of moose, the study found that moose road crossings peak in spring between the end of April and end of June, and peak in winter between mid-November and the beginning of January. Crossings were found to dip in spring between the beginning of March and beginning of April, and dip in summer between the end of June and mid-August. Additional results showed higher probability of collision at higher speed areas and areas that have been human-modified. The findings of this study suggest that, although risk of collision increases with higher moose activity, poor light and road surface conditions may be the greatest factors in increasing the risk of collision.

In a study by Garrett and Conway (1999) of MVCs in Anchorage, Alaska, between 1991 and 1995, it was found that collisions are 2.6 times more likely to occur in the dark than during daytime, with 61% of the collisions occurring in the dark on unlit roadways. The researchers suggested that streetlights be placed in known areas of high moose activity. Garrett and Conway found that weather was a factor in many MVCs, that roads were slick in 54% of all MVCs, and that in 18% of the collisions, visibility was reduced due to weather. However, the study showed that injury was twice as likely to occur on a dry road as on a slick road. During the years with the highest reported MVCs, 1994 and 1995, snow depths varied significantly, with snow depth higher than average in 1994 and lower than average in 1995. This suggests that snow depths may not be directly linked to the number of MVCs, but could adversely affect moose migration and moose populations in a given year or season.

Through their analysis reported in "Multi-scale Spatiotemporal Analyses of Moose-Vehicle Collisions: A Case Study in Northern Vermont," Mountrakis and Gunson (2009) verified that MVCs are clustered in space, time, and space-time. Their analysis results showed that MVCs recur at regular intervals and have a seasonal cyclic component, the majority of collisions occurring from May to October.

In "Spatial and Temporal Characteristics of Moose Highway Crossings During Winter in the Buffalo Fork Valley, Wyoming," Becker et al. (2011) tracked adult female moose in the Buffalo Fork Valley and collected hourly locations during the winter from 2005 to 2007. This information was mapped to estimate the number of highway crossing events within the study area. Becker et al. found that moose cross the highway more frequently during early to mid-evening and less frequently during midday; that moose crossings can be predicted by estimating winter habitat selection characteristics; and that moose crossings accumulate where preferred habitat and landscape features are present on both sides of the highway. The researchers' moose tracking showed a high probability of moose crossing underneath the highway at bridge locations. The results of this study suggest that preferred moose habitat and landscape features are strong indicators in predicting where moose crossings will occur, and that preferred habitat and landscape features have a stronger influence on crossing location than fences.

In their analysis of MVCs in western Maine, Danks and Porter (2010) showed that the proportion of cutover forest within 2.5 km (1.55 mi) of the road is positively correlated with probability of MVCs. They found that traffic amount and speed are the first and third, respectively, most important landscape characteristics related to MVCs. The study results showed that the effect of traffic volume is dependent on speed limit, indicating varying probabilities of MVC for different types of roads. For example, on a local road with a lower speed limit, greater traffic flow increases MVC probability. The opposite is shown for interstate and major arterials with higher speed limits, where MVC probability decreases at higher traffic volumes.

In their study, "Spatial and Temporal Distribution of Moose-Vehicle Collisions in Newfoundland," Joyce and Mahoney (2001) found that, spatially, MVCs are dependent on both moose density and traffic volume. Joyce and Mahoney found that there is a greater probability of MVCs in areas of high or low (but not moderate) moose densities and high traffic flow, and that 75% of all accidents occur between sunset and sunrise.

2.4 Effectiveness of Mitigation Measures

In a review of European, North American, and Japanese literature on ungulate traffic collisions, Bruinderink and Hazebroek (1996) found a lack of strong evidence for the number of kills per crossing being affected by the use of permanent warning signs, 90° light mirrors, scent, or acoustic fencing. In their article "Ungulate Traffic Collisons in Europe," the researchers recommend a combination of fencing and wildlife passages.

Nighttime detection distances on highways were tested by using a life-sized bull moose decoy. As reported by Rodgers and Robins (2006), overall, the mean detection distance was found to be 105 m (344 ft). The researchers' study found that headlamp setting, low beam or high beam, was a significant factor in detection distance. The mean detection with use of a low beam setting was found to be 74 m (243 ft); the mean detection with use of a high beam setting was found to be 137 m (449 ft). This study by Rodgers and Robins determined that drivers travelling at night in excess of 70 km/h (approximately 45 mph) are very likely to be overdriving the illumination capabilities of their headlamps for moose encounters. They determined the safe speed for low beam setting was 60 km/h (approximately 40 mph); the safe speed for high beam setting was 80–90 km/h (approximately 50–55 mph). The results of this study suggest that night speeds should be no higher than 70 km/h in areas where MVCs are a high risk. A possible mitigation measure would be reduced night-driving speeds in high MVC corridors along highways.

In their study, "Effectiveness of Highway Lighting in Reducing Deer-Vehicle Accidents," Reed and Woodard (1981) found that the crossings-per-accident ratios of deer are not significantly different with lighting off and with lighting on. The researchers determined that highway lighting did not affect location of deer crossings, in that deer continue crossing at preferred locations. Reed and Woodard found that winter severity, as indicated by snow and temperature, likely is causally related to numbers of deer and accidents in the study area.

Leblond et al. (2007), as reported in the article "Electric Fencing as a Measure to Reduce Moose-Vehicle Collisions," tested the effectiveness of electric fences in reducing MVCs. The results of their tests showed an 80% reduction in observed moose tracks along highways; only 30% of moose tracks observed were from moose that crossed an operational fence. The researchers found that moose mostly cross the highway at openings where roads intersect or at fence limits. In order for electric fencing to be effective, Leblond, et al. recommend that electric fences be continuous, circuit breakers be used to prevent power failures, breaks in fence line occur only where anti-ungulate structures are used, unpowered cables be used next to lakes, fences be equipped with a failure-detection system, and frequent physical checks be required. Although electric fences may be less expensive and have a lower visual impact than conventional metal fences, this type of mitigation promised to be extremely cumbersome.

Seiler (2005) used a MVC predictive model to show that the amount and proximity of forest habitat that provides cover and forage significantly affects the risk of MVC, with a 15% reduction in risk of collision with an increase of 100 m (328 ft) distance between forest cover and the road. The results of this study, "Predicting Locations of Moose-Vehicle Collisions in Sweden," showed that, if vehicle speed and moose density are simultaneously increased, the effect of forest proximity is weaker. For sections of Alaska's highway system where traffic and speed limits are highest, clearing would be a less effective mitigation measure than on low-volume low-speed roads. Seiler's results showed a nonlinear relation between traffic volume and vehicle speed that peaked at intermediate speed limits and intermediate traffic volumes, suggesting that intensive traffic may repel wildlife from approaching roads and thereby reduce the likelihood of accidents. Seiler found that MVCs were most likely to occur on unfenced roads with intermediate traffic volumes and intermediate speed limits.

No body of knowledge was found specifically on the relation between clearing, grubbing and/or roadway illumination and MVC. Glista et al. (2009) reported in their literature review that very few before-and-after studies have been done to evalute mitigation effectiveness.

2.5 Management Implications

As reported in "A Review of Mitigation Measures for Reducing Wildlife Mortality of Roadways," Glista et al. (2009) recommend that preconstruction planning, connectivity of habitat and permeability of road systems, financial considerations, and efficiency all be included in wildlife collison reduction. They reported that structural methods, although more expensive, are probably more effective at reducing collisions. The structural mitigation measures identified were crossing structures, that is, which overpasses and uderpasses would be applicable to moose. The nonstructural methods identified were repellents, ultrasound, road lighting, population control, and habitat modification.

Moose-vehicle collisions were found to be a product of various environmental factors including landscape, road and traffic characteristics, moose migration and behavior, moose density, vehicle speed, traffic volume, visibility in relation to lighting, and the amount of and proximity to preferred habitat. These factors are not exclusive and affect the significance of one another. Therefore, determining effective mitigation measures will need to include all elements present in a given corridor where MVCs are high. Less effective mitigation measures for reducing MVCs have been identified as permanent warning signs, 90° light mirrors, scent, or acoustic fencing. Reported effective mitigation measures include fencing, wildlife passages, reduced night-driving speeds, population control, and roadside illumination.

Chapter 3 Data Collection and Characteristics

Crash data were collected from the Alaska Department of Transportation and Public Facilities Statewide Crash Database (DOT&PF, 2016). The crash data, sorted to include only crashes that involved moose collisions, were grouped by road segment. Once sorted, the data were further refined to eliminate crashes outside the improvement corridor and outside the 10-year analysis period.

Construction as-builts were reviewed to determine improvement corridors by milepost (MP), mile point, construction dates, and types of improvements preformed. The crash data range was selected based on the construction date, taking the completion date as the year the project was built. The crash data range is a 10-year analysis period, 5 years before and after the completion year. Table 2 lists each road segment analyzed along with corridor milepost limits, mile point range, construction dates, and improvement information.

Sweanor and Sandegren (1989) found that long durations of snow deeper than 27.6 inches affected winter home-range size. For this reason, snow depth was a crucial variable to collect. Precipitation and snow data were obtained from climate data annual summaries of weather stations near the road segments studied and can be found in Appendix D (NOAA).

Several studies have shown seasonal patterns in moose, with many studies performed during summer (example, Leblond et al., 2010) and winter (example, Sweanor and Sandegren, 1989). Leblond et al. found that moose movement differs among annual periods. For this reason, each year in the study needed to range from the beginning of a season to another, not by year alone. The annual precipitation data were grouped from fall to summer. This approach corresponds well with the construction season in Alaska, as shown by the as-built review. October was found to be a common completion date. Since weather data were summarized by month, October was selected as the starting month for the study year, which aligns closely with the start of the fall season that begins on the fall equinox, approximately September 22. This approach also groups the full snowfall data for the winter season into one study year.

Moose population information was gathered from Alaska Department of Fish and Game (ADF&G) Moose Management Reports (Alaska Department of Fish and Game (ADF&G), 1989–2011). For Game Management Unit (GMU) 14A, population surveys have historically been conducted during fall and winter months, typically November and December, but have ranged from October to February. In GMU 14B, population surveys have been conducted in fall, usually in October and November. For GMU 14C, surveys are conducted annually in the fall and early winter. In GMU 15A, moose population surveys are conducted in November and December each year. For GMU 15B, surveys are typically conducted in November and December, but one year the survey was conducted in February. For this reason, the yearly moose population estimates have been assigned accordingly, matching the same study year as precipitation data.

Table 2. Study Areas by Corridor and Improvement Information

Route No.	Road Segment	MP Est	Mile point Range	Construction Dates	Year Built	Crash Data Range	Road Type	Continuous Lighting	Clearing and Grubbing	Clearing	GMU
110000	Sterling Highway	82.0-93.72	47.3999-56.5237	8/13/1991-10/24/1991	~1991	1986-1996	2 Ln	No	Yes	N/A	15A
115400	Kalifornsky Beach Road	MP 16.4-22.4	16.4-22.4	7/28/1999-8/6/2001	~2001	1996-2006	3 Ln	No	Yes	N/A	15B
135000	Glenn Highway	MP 4-11.	4.0-11.9	1/12/1987-9/20/1988	~1988	1983-1993	6 Ln Frwy	Yes	Yes	N/A	14C
135000	Glenn Highway	MP 3.24-11.46	3.24-11.46	Unknown	~2000	1995-2005	6 Ln Frwy	Yes	No	No	14C
135000	Glenn Highway	MP 30.7-33.5	30.7827-33.1182	9/5/2001-7/18/2002	~2002	1997-2007	4 Ln Frwy	Yes	Yes	N/A	14A
135000	Glenn Highway	MP 12.082-16.5	12.0327-16.5540	6/18/2007-9/23/2008	~2008	2003-2013	4 Ln Frwy	Yes	No	No	14C
170000	Parks Highway	MP 35-37	0-1.79	8/30/1999-10/31/2000	~2000	1995-2005	4 Ln Frwy	Replaced Existing	Yes	N/A	14A
170000	Parks Highway	MP 37-39	1.79-4.1617	10/12/2001-8/2004	~2004	1999-2009	4 Ln Frwy	No	Yes	N/A	14A
170000	Parks Highway	MP 72-83	36.3431-47.7586	10/21/2009-8/31/2011	~2011	2006-2016	2 Ln	No	No	Yes	14B
170044	Knik-Goose Bay Road	MP 0.0-19.56	0.0-7.0	8/4/2003-6/30/2005	~2005	2000-2010	2 Ln	No	Yes	N/A	14A

3.1 Sterling Highway Milepost MP 82.0–93.72

The Sterling Highway MP 82.0–93.72 project is located in GMU 15A. Moose population information for GMU 15A was gathered from ADF&G Moose Management Reports; additional information was provided by ADF&G. Linear population interpolations were conducted to estimate moose population for years when population surveys were not conducted, as shown in Figure 2.

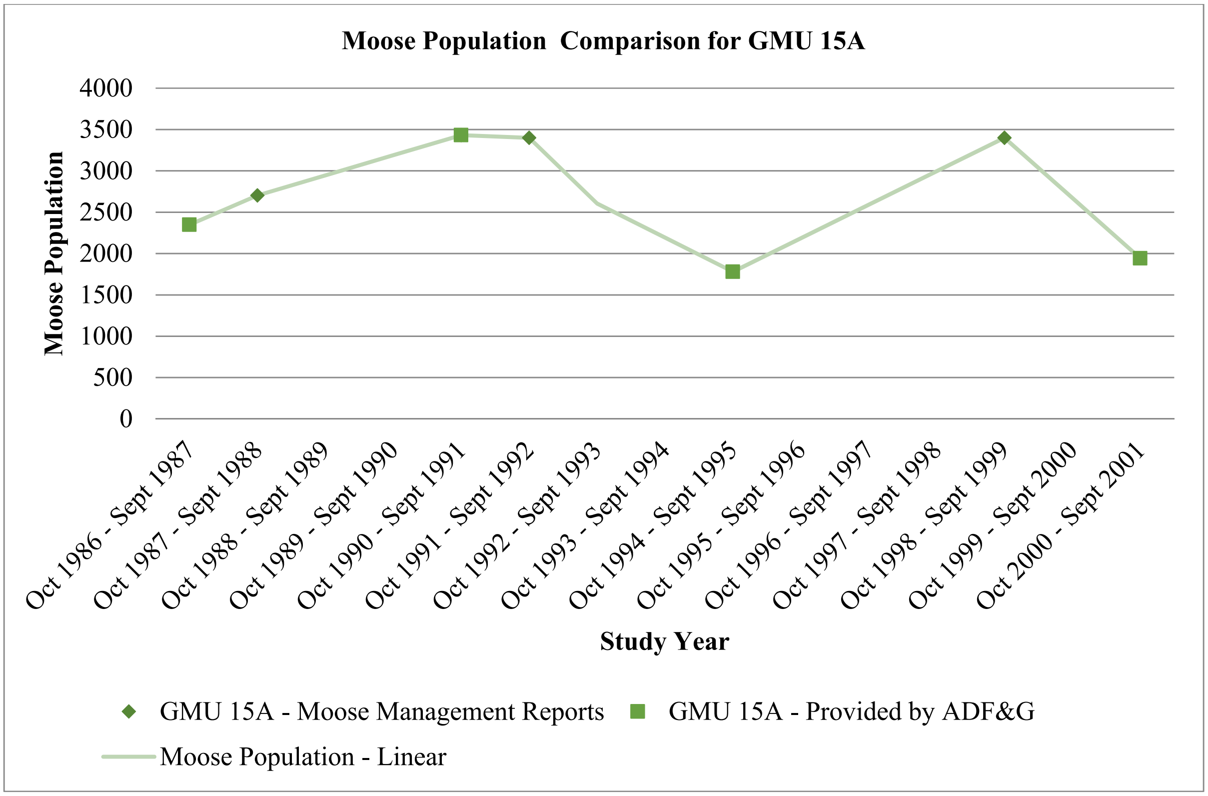

Figure 2. Moose Population Comparison for GMU 15A

Weather information was gathered from weather station KENAI MUNICIPAL AIRPORT, AK US COOP: 504546, the closest weather station to the project corridor with complete precipitation data. The linear moose population estimate and the precipitation data were charted to compare data trends (see Appendix A, Figures A.1-A.3). Figure A.1 shows that the number of reported moose-vehicle collisions (MVCs) follows a similar trend as recorded precipitation information, dipping and rising the same years as precipitation. Moose-vehicle collisions closely follow the same trend per year as maximum snow depth and snowfall, as depicted in Figures A.2 and A.3. The highest collision years were not the highest snowfall or maximum snow depth years, so other factors are contributing to MVCs. The lowest dip in MVCs occurred the second-year post project completion. The five-year average number of reported accidents prior to construction completion was 14.8 MVCs/year and the five-year average post construction completion was 13.4 MVCs/year, a 9.5% decrease.

3.2 Kalifornsky Beach Road MP 16.4–22.4

The Kalifornsky Beach Road MP 16.4–22.4 project is located in GMU 15B. Moose population information for GMU 15B was gathered from ADF&G Moose Management Reports. Moose population surveys were not conducted during several years of the study period, so moose population trends from GMU 15A and GMU 15C were compared with GMU 15B to estimate those years. Using those trends, a linear population estimate was used to determine the population estimate for years when population surveys were not conducted, as shown in Figure 3.

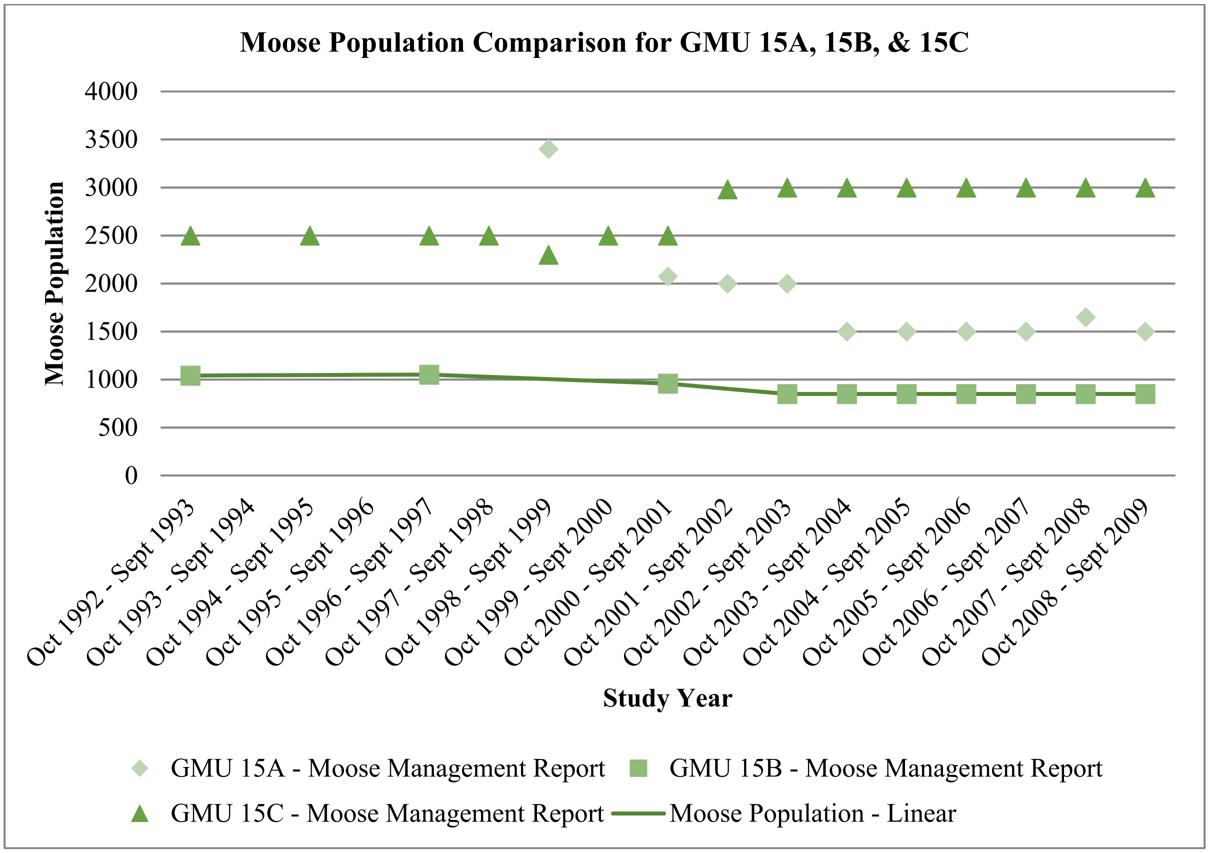

Figure 3. Moose Population Comparison for GMU 15B

Weather information was gathered from weather stations HOMER 8 NW, AK US COOP: 503672, KENAI MUNICIPAL AIRPORT, AK US COOP: 504546, KASILOF 3 NW, AK US COOP: 504425, SOLDOTNA 5 SSW, AK US COOP: 508615, KENAI 9 N, AK US GHCND: USC00504550, and Kenai Moose Pens, AK US GHCND: USS0050L02S. Every weather station had incomplete precipitation data or incomplete or missing snowfall data for the study period, so a comparison of the collective information was done, as seen in Figure 4. A combination of the data was used from weather stations KENAI MUNICIPAL AIRPORT, AK US COOP: 504546, SOLDOTNA 5 SSW, AK US COOP: 508615, KENAI 9 N, AK US GHCND: USC00504550, and Kenai Moose Pens, AK US

GHCND: USS0050L02S to estimate full precipitation for the project corridor. These weather stations were regionally close to the corridor and had very similar precipitation readings, as seen in Figure 4.

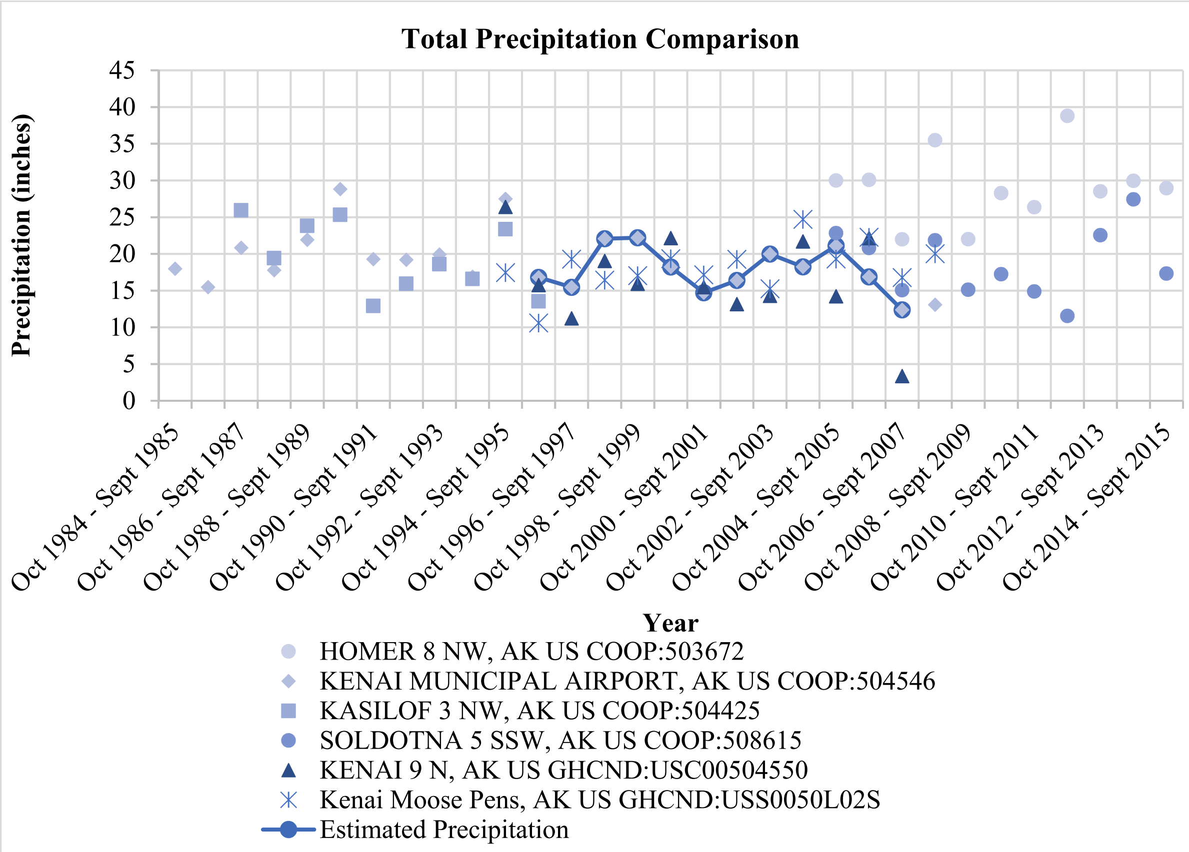

Figure 4. Total Precipitation Comparison

Taking the linear moose population estimate and the estimated precipitation data, graphs were made to compare trends in data (see Appendix A, Figures A.4-A.6). Figure A.4 shows that the number of reported MVCs follows a similar trend as recorded precipitation information, except in the study years October 1999–September 2000 and October 2001–September 2002, where high precipitation is paired with a drop in MVCs. This same trend can be seen with maximum snow depth and snowfall, as shown in Figure A.5 and Figure A.6. The lowest number of MVCs occurred in the construction year and the year following project completion. The five-year average number of reported accidents prior to construction completion was 9.6 MVCs/year and the five-year average post construction completion was 5.6 MVCs/year, a 41.7% decrease.

3.3 Glenn Highway MP 4–11

The Glenn Highway MP 4–11 project is located in GMU 14C. Moose population information for GMU 14C was gathered from ADF&G Moose Management Reports. Moose population surveys were not conducted during several years in the study period, so moose population trends from GMU 14A and GMU 14B were collected and compared with GMU 14C to estimate those years. Using those trends, a linear population estimate was used to determine the population for years when population surveys were not conducted, as shown in Figure 5.

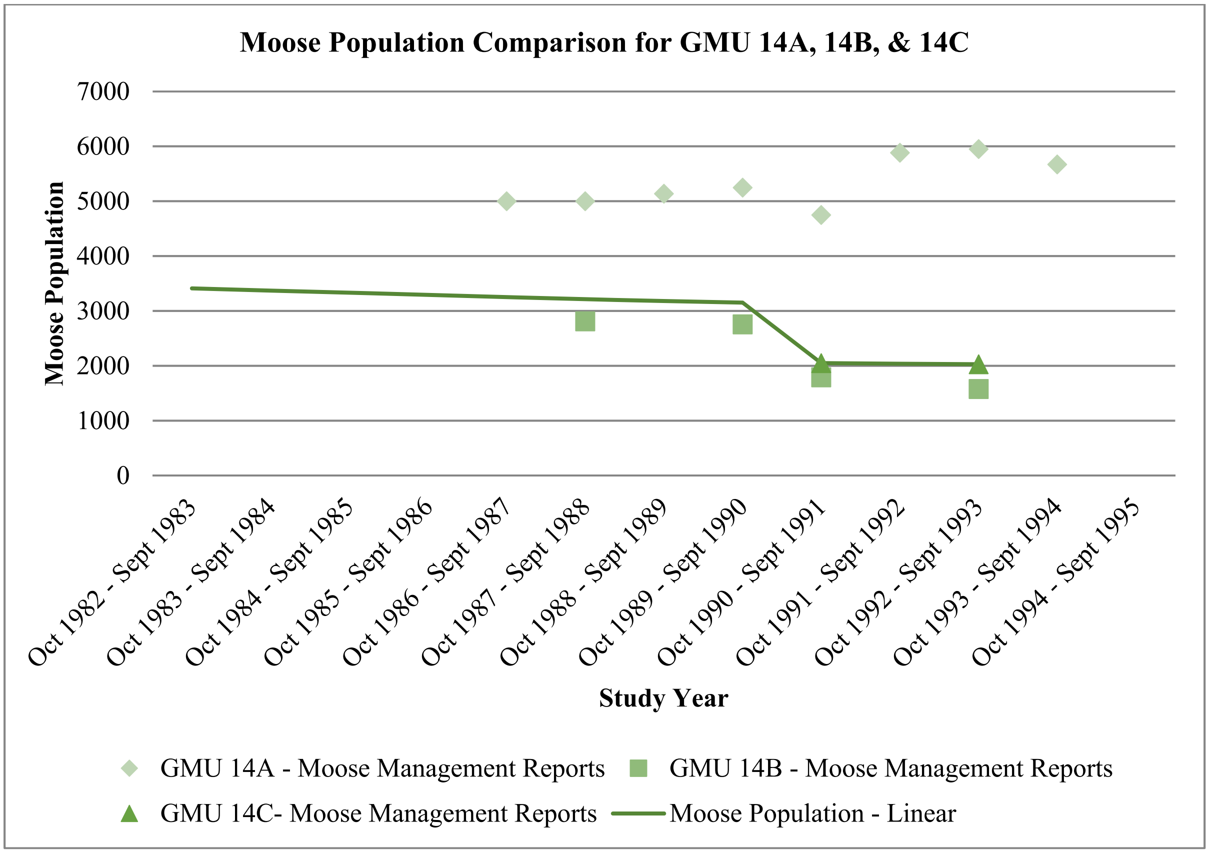

Figure 5. Moose Population Comparison for GMU 14C

Weather information was gathered from weather stations ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280, and ANCHORAGE ELMENDORF AFB, AK US COOP: 502820. The weather station ANCHORAGE ELMENDORF AFB, AK US COOP: 502820, which is located closer to the project corridor, did not have complete precipitation data for the entire study period, so a comparison of data from both weather stations was made, as seen in Figure 6. Precipitation values were very similar, except for the 2 years of incomplete data for ANCHORAGE ELMENDORF AFB, AK US COOP: 502820, October 1984–September 1985 and October 1985–September 1986. For this reason, data from weather station ANCHORAGE TED STEVENS

INTERNATIONAL AIRPORT, AK US COOP: 500280 were used to estimate full precipitation for the project corridor.

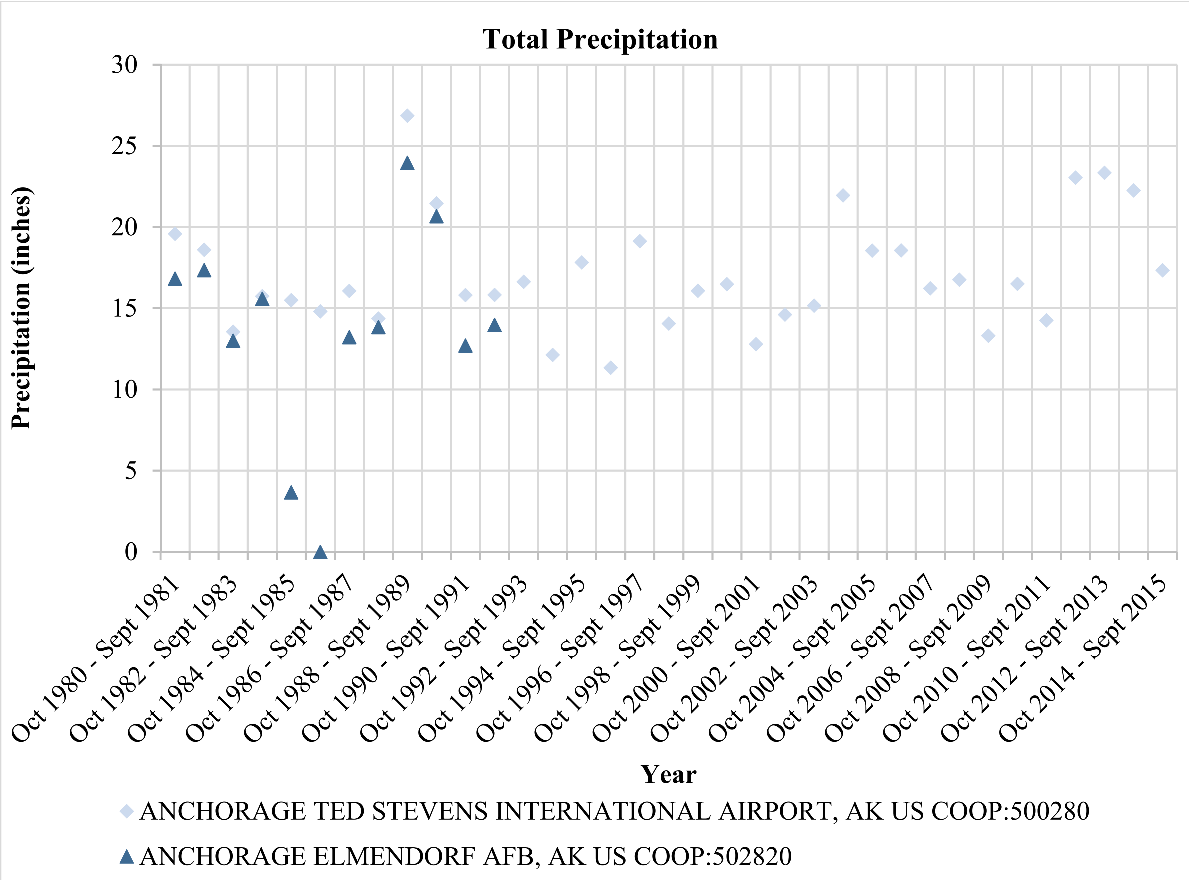

Figure 6. Total Precipitation Comparison

Taking the linear moose population estimate and the precipitation data, graphs were made to compare trends in data (see Appendix A, Figures A.7-A.9). Figure A.7 indicates that the number of reported MVCs does not follow the same trend as the recorded precipitation information. The MVCs seem to rise and fall independent of the precipitation data during the first five years of the study. Then in the last five years, the MVCs follows a similar trend as recorded precipitation information, dipping and rising the same years as precipitation. This same independent relationship can be seen with maximum snow depth and snowfall in the first five years of the study, as shown in Figure A.8 and Figure A.9. Then in the last five years, the number of MVCs rise and fall in a similar trend as maximum snow depth and snowfall. The lowest number of MVCs occurred in the first year following project completion, as well as 5 years post-completion date. The five-year average number of reported accidents prior to construction completion was 30.8 MVCs/year and the five-year average post construction completion was 13.6 MVCs/year, a 55.8% decrease.

3.4 Glenn Highway MP 3.24–11.46

The Glenn Highway MP 3.24–11.46 project is located in GMU 14C. Moose population information for GMU 14C was gathered from ADF&G Moose Management Reports. Linear population interpolations were conducted to estimate moose population for years when population surveys were not conducted, as shown in Figure 7.

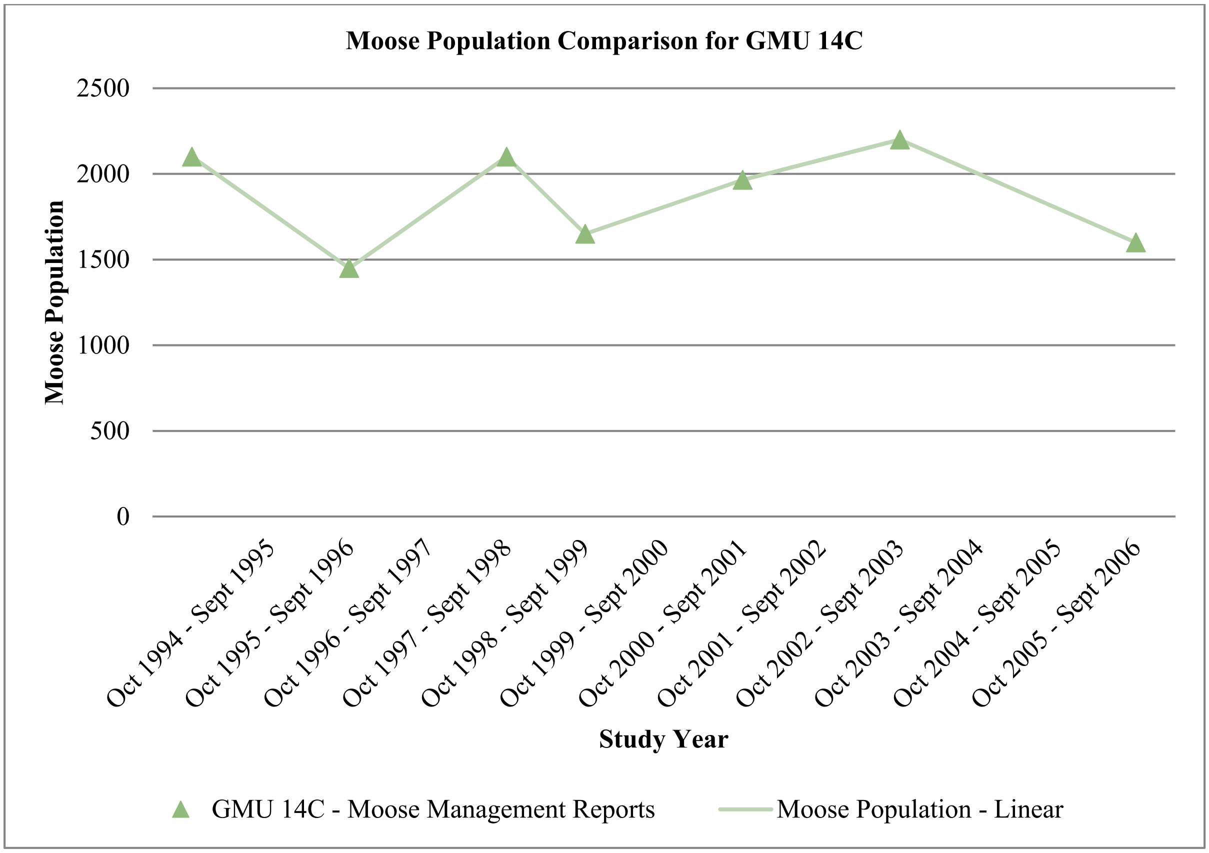

Figure 7. Moose Population Comparison for GMU 14C

Weather information was gathered from weather station ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280, the closest weather station to the project corridor with complete precipitation data. The linear moose population estimate and the precipitation data were charted to compare data trends (see Appendix A, Figures A.10-A.12). Figure A.10 shows that the number of reported MVCs does not follow the same trend as recorded precipitation information, dipping and rising independently of precipitation. The same independent trend is seen with maximum snow depth and snowfall, as depicted in Figure A.11 and Figure A.12. The highest collision years were not the highest snowfall or maximum snow depth years, so other factors are contributing to MVCs. The lowest number of MVCs occurred 5 years prior to project completion and four years post project completion. The five-year average number of reported accidents prior to construction completion was

12.0 MVCs/year and the five-year average post construction completion was 17.2 MVCs/year, a 43.3% increase.

3.5 Glenn Highway MP 30.7–33.5

The Glenn Highway MP 30.7–33.5 project is located in GMU 14A. Moose population information for GMU 14A was gathered from ADF&G Moose Management Reports. Linear population interpolations were conducted to estimate moose population for years when population surveys were not conducted, as shown in Figure 8.

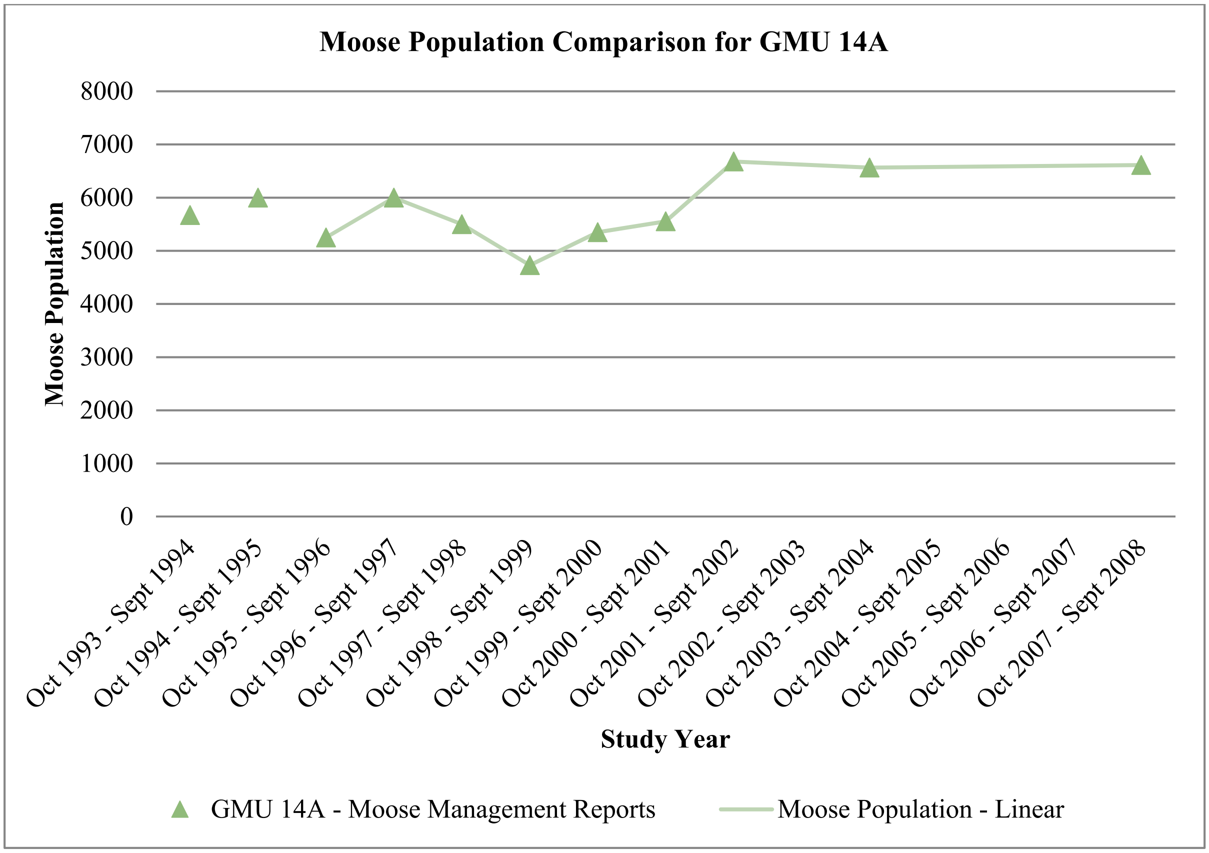

Figure 8. Moose Population Comparison for GMU 14A

Weather information was gathered from weather stations ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 and PALMER JOB CORPS, AK US COOP: 506870. The weather station PALMER JOB CORPS, AK US COOP: 506870, which is located closer to the project corridor, did not have complete precipitation data for the entire study period, so a comparison of data from both weather stations was made, as seen in Figure 9. There was only 1 year of complete precipitation data for PALMER JOB CORPS, AK US COOP: 506870 during the study period, October 2006–September 2007. For this reason, data from weather station ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 were used to estimate full precipitation for the project corridor.

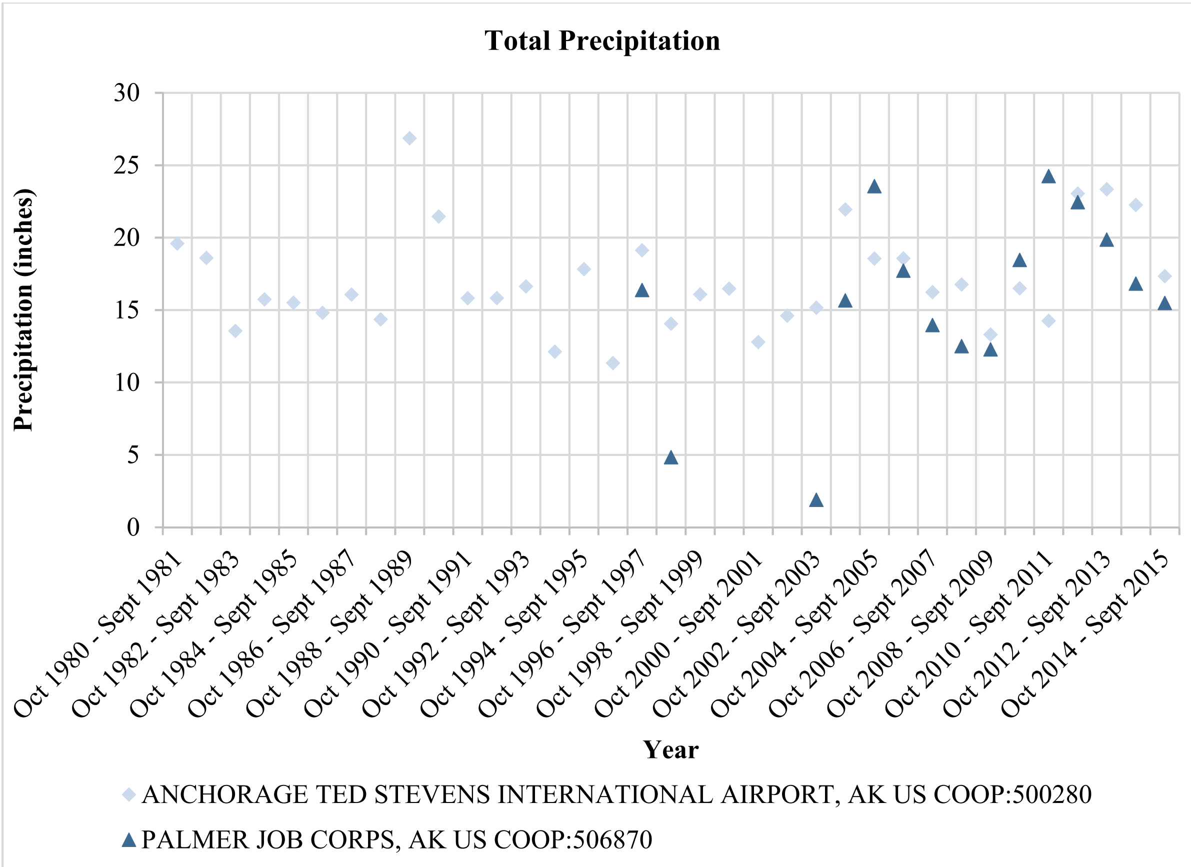

Figure 9. Total Precipitation Comparison

The linear moose population estimate and the precipitation data were charted to compare data trends (see Appendix A, Figures A.13-A.15). As shown in Figure A.13, the number of reported MVCs follows a similar trend as recorded precipitation information, dipping and rising the same years as precipitation, except for the study years October 2001–September 2002, October 2003–September 2004, and October 2006–September 2007. These study years had the highest snowfall and maximum snow depth, as depicted in Figure A.14 and Figure A.15, indicating that years of significant snowfall and maximum snow depth lead to a reduced number of reported MVCs in the study area. The lowest dip in MVCs occurred the second year post project completion as well as 5 years post project completion. The five-year average number of reported accidents prior to construction completion was 4.6 MVCs/year and the five-year average post construction completion was 2.4 MVCs/year, a 47.8% decrease.

3.6 Glenn Highway MP 12.082–16.5

The Glenn Highway MP 12.082–16.5 project is located in GMU 14C. Moose population information for GMU 14C was gathered from ADF&G Moose Management Reports, and additional information was provided by ADF&G. Moose population trends from GMU 14A provided by ADF&G were used to estimate moose population for years when population surveys were not conducted using linear interpolation, as shown in Figure 10.

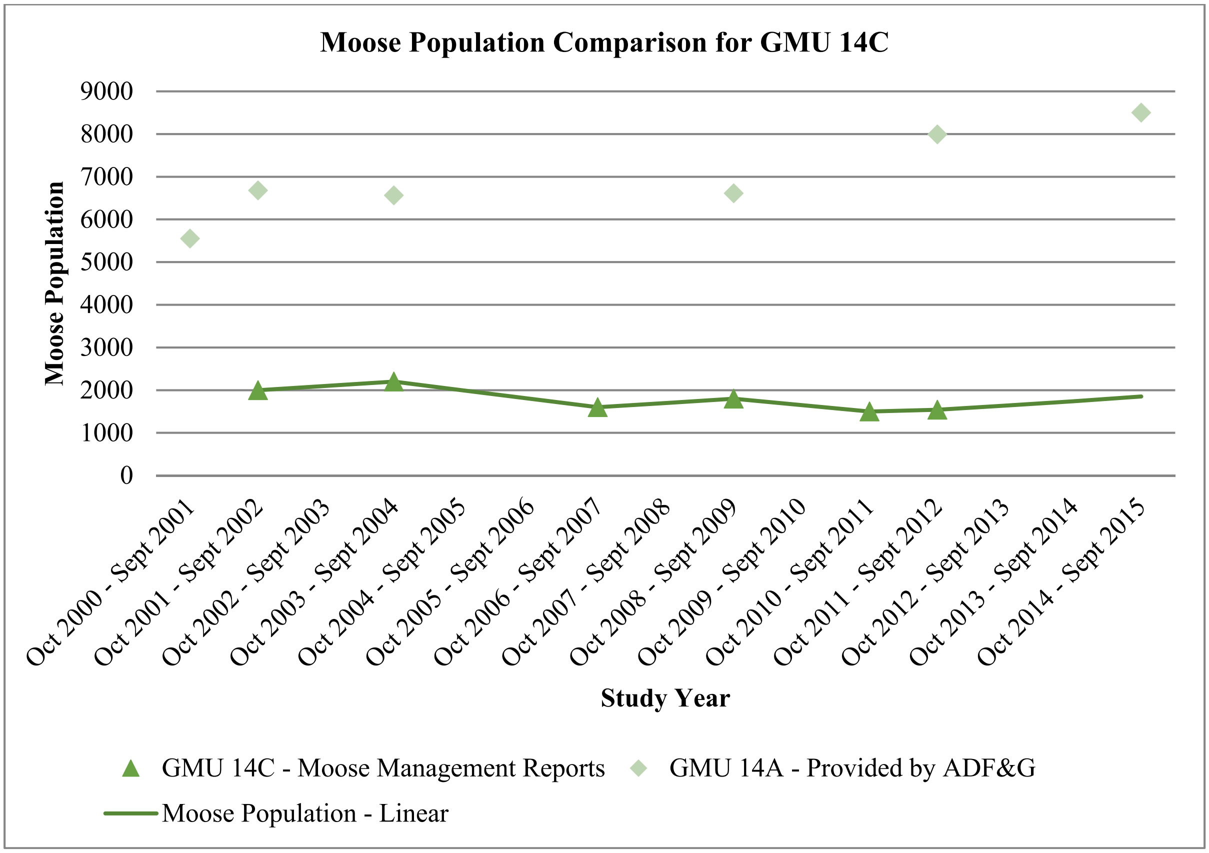

Figure 10. Moose Population Comparison for GMU 14C

Weather information was gathered from weather stations ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 and PALMER JOB CORPS, AK US COOP: 506870. The weather station PALMER JOB CORPS, AK US COOP: 506870, which is located closer to the project corridor, did not have complete precipitation data for the entire study period, so a comparison of data from both weather stations was made, as seen in Figure 9. There were only 3 years of complete precipitation data for PALMER JOB CORPS, AK US COOP: 506870 during the study period: October 2006–September 2007, October 2008–September 2009, and October 2009–September 2010. For this reason, data from weather station ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 were used to estimate full precipitation for the project corridor.

The linear moose population estimate and the precipitation data were charted to compare data trends (see Appendix A, Figures A.16-A.18). Figure A.16 shows that the number of reported MVCs does not appear to have any sort of pattern related to the recorded precipitation information. The study years with the highest snowfall and maximum snow depth are paired with years of high and low reported MVCs, as depicted in Figure A.17 and Figure A.18. A peak in MVCs occurred the first year after construction completion, although there appears to be a trend of reduced MVCs after construction, with the lowest dip in MVCs occurring 4 and 5 years post project completion. The five-year average number of reported accidents prior to construction completion was 5.6 MVCs/year and the five-year average post construction completion was 2.8 MVCs/year, a 50.0% decrease.

3.7 Parks Highway MP 35–37

The Parks Highway MP 35–37 project is located in GMU 14A. Moose population information for GMU 14A was gathered from ADF&G Moose Management Reports, and additional information was provided by ADF&G. Linear population interpolations were conducted to estimate moose population for years when population surveys were not conducted, as shown in Figure 11.

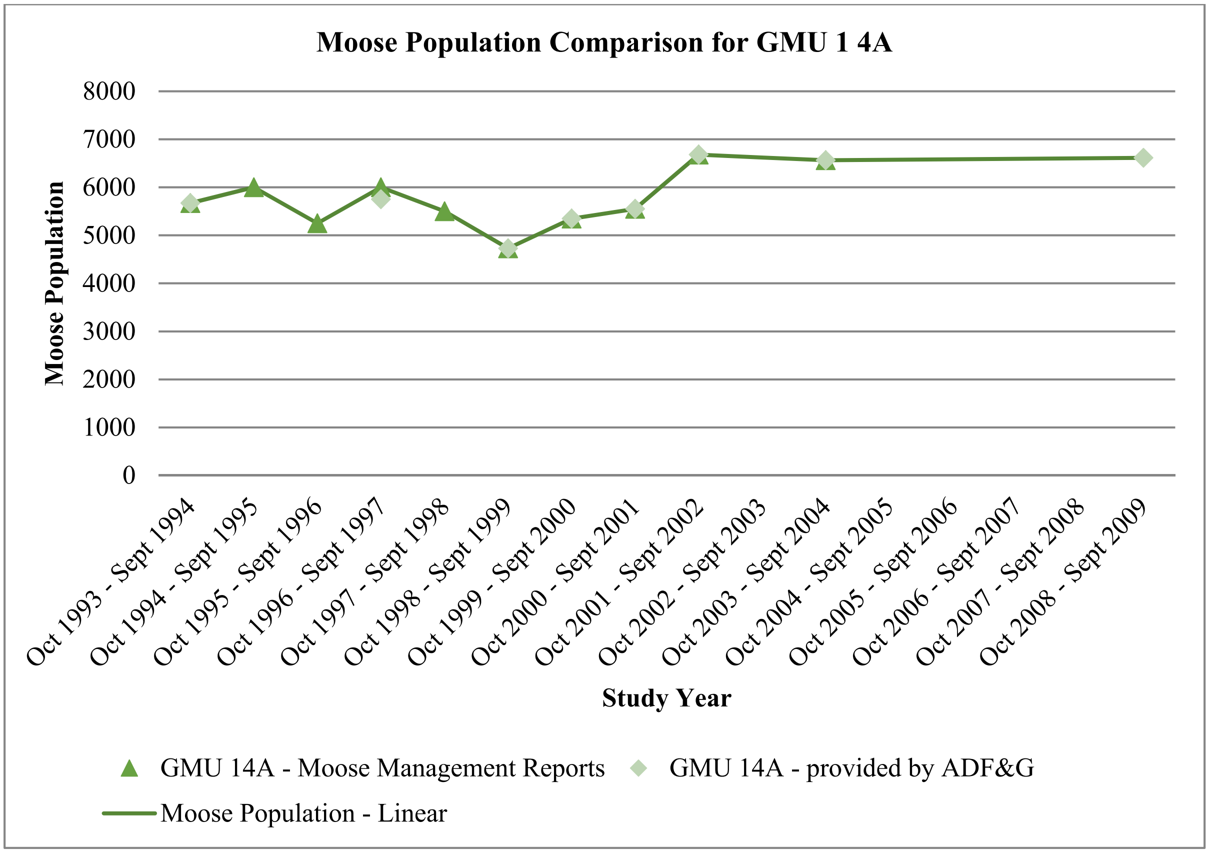

Figure 11. Moose Population Comparison for GMU 14A

Weather information was gathered from weather stations ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 and PALMER JOB CORPS, AK US COOP: 506870. The weather station PALMER JOB CORPS, AK US COOP: 506870, which is located closer to the project corridor, did not have complete precipitation data for the entire study period, so a comparison of data for both weather stations was made, as seen in Figure 12. There was only 1 year of complete precipitation data for PALMER JOB CORPS, AK US COOP: 506870 during the study period October 1996–September 1997. For this reason, data from weather station ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 were used to estimate full precipitation for the project corridor.

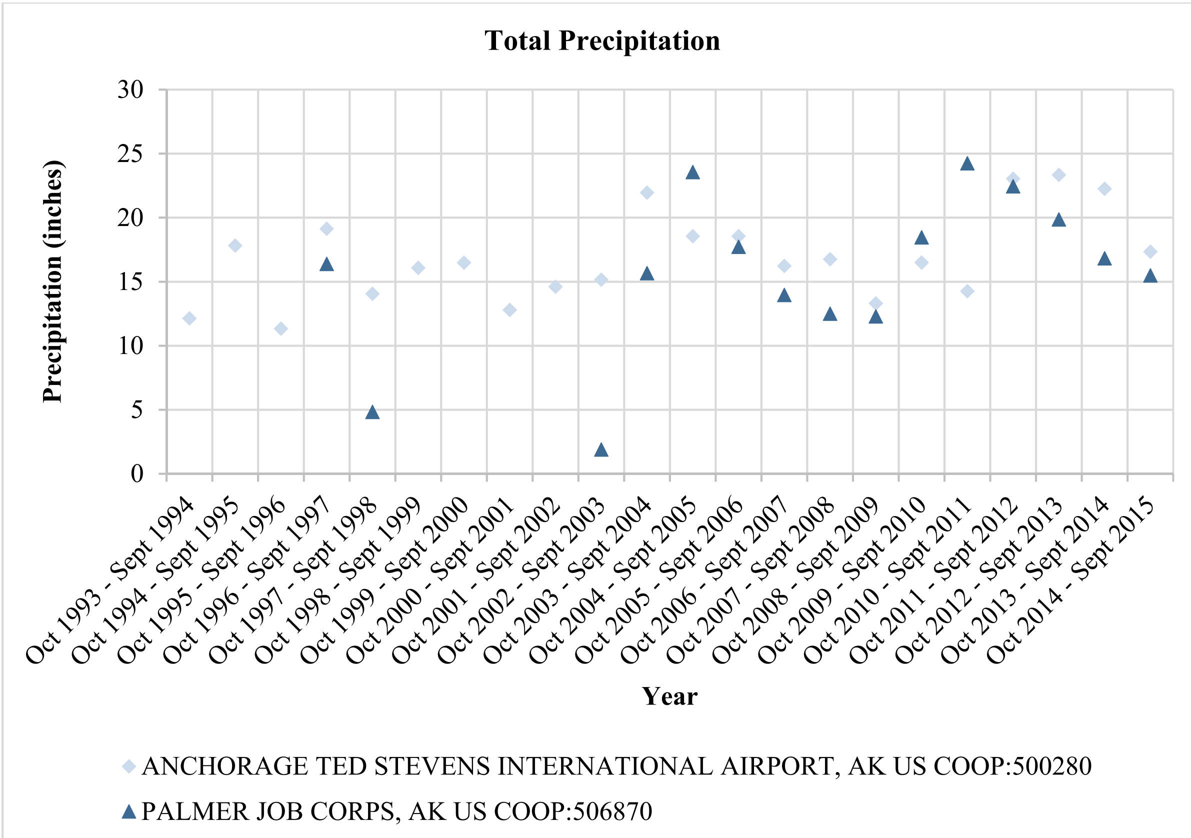

Figure 12. Total Precipitation Comparison

The linear moose population estimate and the precipitation data were charted to compare data trends (see Appendix A, Figures A.19-A.21). Figure A.19 shows that the number of reported MVCs does not appear to have any relation to the recorded precipitation information. Most years in the study period did not experience any MVCs and is likely due to a short corridor. Figure A.20 and Figure A.21 show the number of MVCs in relation to maximum snow depth and snowfall, respectively. There does not appear to be a trend of reduced MVCs after construction, but rather an increase. The highest MVCs occurred 4 and 5 years post-project completion. The five-year average number of reported accidents prior to construction completion was 0.4 MVCs/year and the five-year average post construction completion was 0.8 MVCs/year, a 100% increase.

3.8 Parks Highway MP 37–39

The Parks Highway MP 37–39 project is located in GMU 14A. Moose population information for GMU 14A was gathered from ADF&G Moose Management Reports, and additional information was provided by ADF&G. Linear population interpolations were conducted to estimate moose population for years when population surveys were not conducted, as shown in Figure 13.

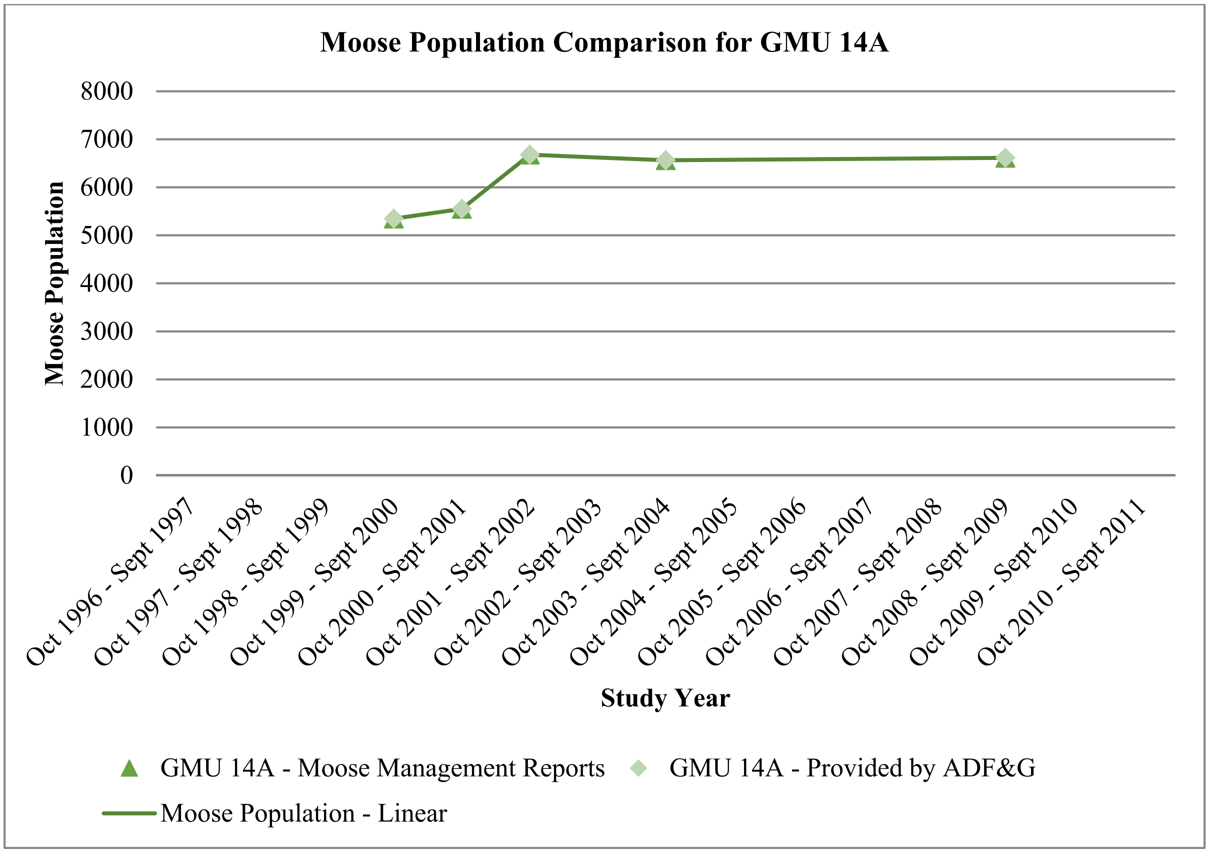

Figure 13. Moose Population Comparison for GMU 14A

Weather information was gathered from weather stations ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 and PALMER JOB CORPS, AK US COOP: 506870. The weather station PALMER JOB CORPS, AK US COOP: 506870, which is located closer to the project corridor, did not have complete precipitation data for the entire study period, so a comparison of data from both weather stations was made, as seen in Figure 12 (see Section Parks Highway MP 35-37). There were only 2 years of complete precipitation data for PALMER JOB CORPS, AK US COOP: 506870 during the study period: October 2006–September 2007 and October 2008–September 2009. For this reason, data from weather station ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 were used to estimate full precipitation for the project corridor.

The linear moose population estimate and the precipitation data were charted to compare data trends (see Appendix A, Figures A.22-A.24). Figure A.22 shows that the number of reported MVCs does not appear to have any relation to the recorded precipitation information. The study years with the highest snowfall and maximum snow depth are paired with years of high and low reported MVCs, as depicted in Figure A.23 and Figure A.24. There does not appear to be a trend of reduced MVCs after construction. The lowest dip in MVCs occurred 1 and 3 years post construction completion as well as two years prior to construction completion. The five-year average number of reported accidents prior to construction completion was 2.2 MVCs/year and the five-year average post construction completion was 1.4 MVCs, a 36.4% decrease.

3.9 Parks Highway MP 72–83

The Parks Highway MP 72–83 project is located in GMU 14B. Moose population information for GMU 14B was gathered from ADF&G Moose Management Reports, and additional information was provided by ADF&G. Moose population surveys were not conducted during several years in the study period, so moose population trends from GMU 14A and GMU 16B were compared with GMU 14B to estimate those years. Using those trends, a linear interpolation was used to determine the population estimate for years when population surveys were not conducted, as shown in Figure 14.

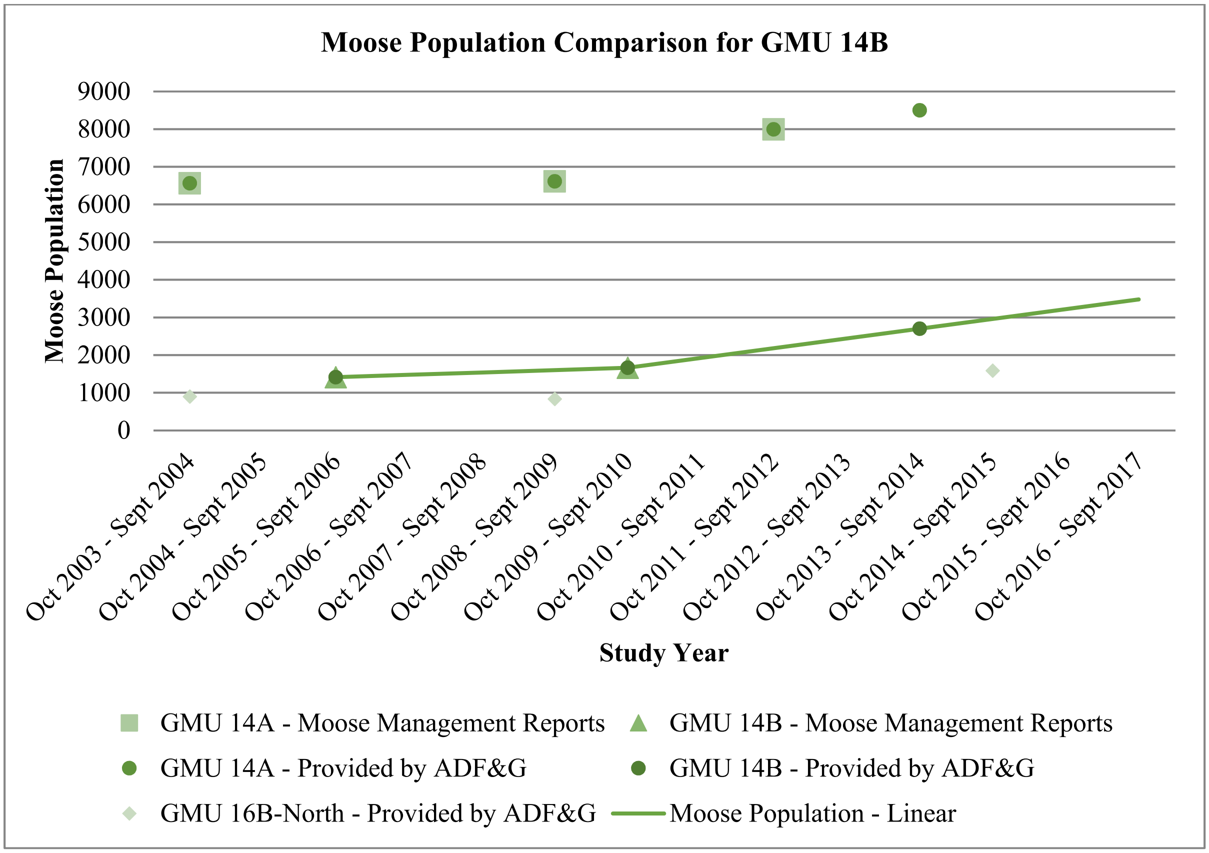

Figure 14. Moose Population Comparison for GMU 14B

Weather information was gathered from weather stations ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 and PALMER JOB CORPS, AK US COOP: 506870. The weather station PALMER JOB CORPS, AK US COOP: 506870, which is located closer to the project corridor, did not have complete precipitation data for the entire study period, so a comparison of data from both weather stations was made, as seen in Figure 12 (see Section Parks Highway MP 35-37). There were 4 years of complete precipitation data for PALMER JOB CORPS, AK US COOP: 506870 during the study period, October 2006–September 2007, October 2008–September 2009, October 2009–September 2010, October 2013–September 2014, and October 2014–

September 2015. For this reason, data from weather station ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 were used to estimate full precipitation for the project corridor. Weather information was not yet available for the full October 2015–September 2016 study year.

The linear moose population estimate and the precipitation data were charted to compare data trends (see Appendix A, Figures A.25-A.27). Figure A.25 shows that the number of reported MVCs does not appear to have any relation to the recorded precipitation information. Figure A.26 and Figure A.27 show the number of MVCs in relation to maximum snow depth and snowfall, respectively. There does not appear to be a trend of reduced MVCs after construction. The lowest dip in MVCs occurred 2 years post-project completion, as well as 4 and 1 years prior to construction completion. The five-year average number of reported accidents prior to construction completion was 5.2 MVCs/year and the two-year average post construction completion was 2.0 MVCs/year, a 61.5% decrease although the study period post construction is shorter than the other projects analyzed.

3.10 Knik-Goose Bay Road MP 0.0–19.56

The Knik-Goose Bay Road MP 0.0–19.56 project is located in GMU 14A. Moose population information for GMU 14A was gathered from ADF&G Moose Management Reports, and additional information was provided by ADF&G. Linear population interpolations were conducted to estimate moose population for years when population surveys were not conducted, as shown in Figure 15.

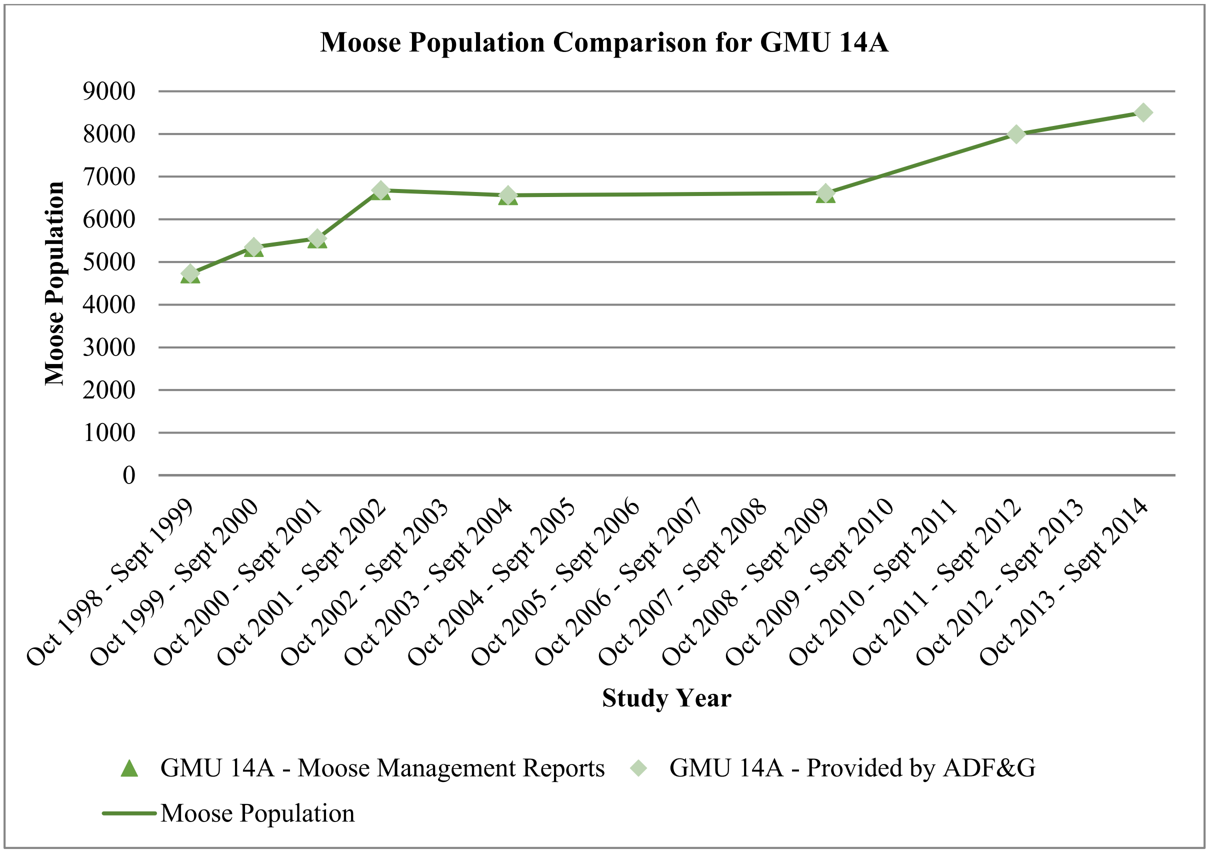

Figure 15. Moose Population Comparison for GMU 14A

Weather information was gathered from weather stations ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 and PALMER JOB CORPS, AK US COOP: 506870. The weather station PALMER JOB CORPS, AK US COOP: 506870, which is located closer to the project corridor, did not have complete precipitation data for the entire study period, so a comparison of data from both weather stations was made, as seen in Figure 16. There were only 3 years of complete data for PALMER JOB CORPS, AK US COOP: 506870: October 2006–September 2007, October 2008–September 2009, and October 2009–September 2010. For this reason, data from weather station ANCHORAGE TED STEVENS INTERNATIONAL AIRPORT, AK US COOP: 500280 were used to estimate full precipitation data for the project corridor.

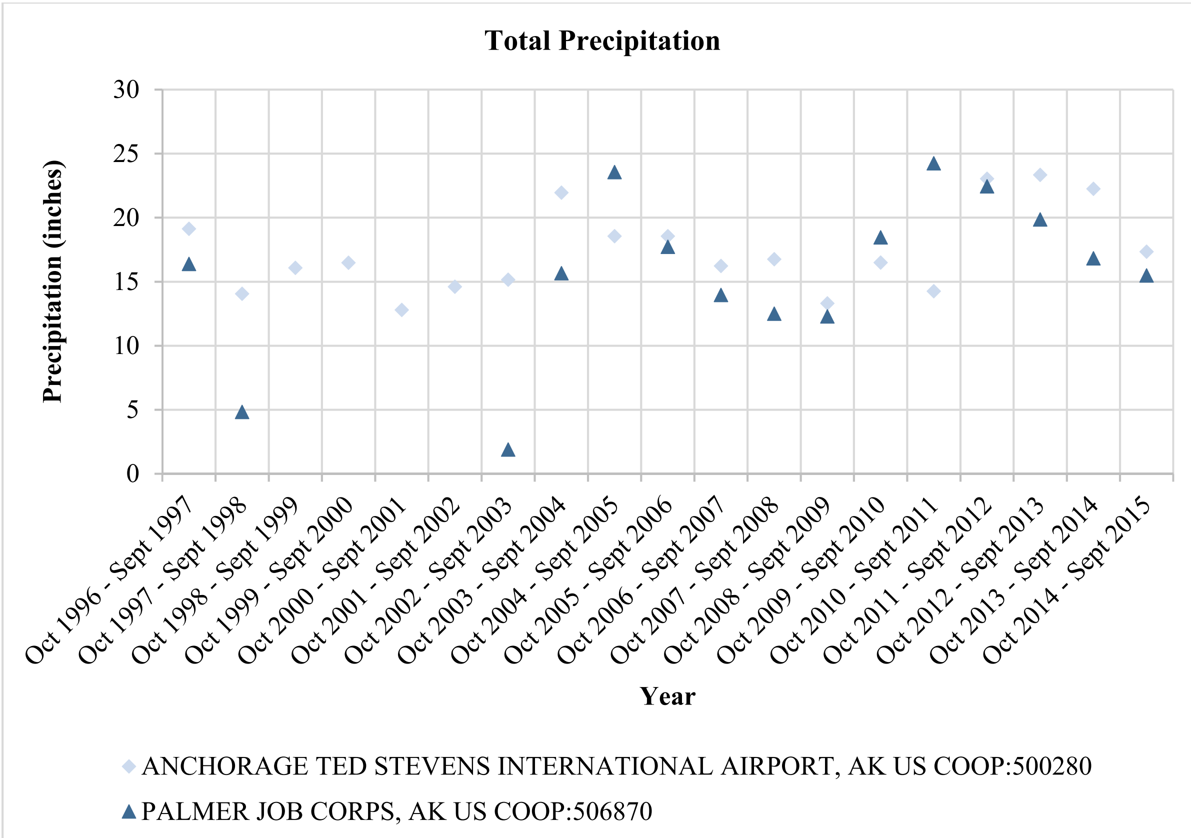

Figure 16. Total Precipitation Comparison

The linear moose population estimate and the precipitation data were charted to compare data trends (see Appendix A, Figures A.28-A.30). Figure A.28 shows that the number of reported MVCs does not follow the same trend as recorded precipitation information exactly, but does rise and fall similarly most years. The study years with the highest snowfall and maximum snow depth are paired with years of high and moderate reported MVCs, as depicted in Figure A.29 and Figure A.30. The lowest recorded MVC year occurred 3 years prior to project completion during the lowest snowfall year. The five-year average number of reported accidents prior to construction completion was 8.4 MVCs/year and the five-year average post construction completion was 10.0 MVCs, a 19.0% increase.

Chapter 4 Research Approach

The goal of the analysis was to determine if the number of MVCs (number of reported accidents with moose) was reduced based on the measures of clearing and grubbing, continuous lighting, or both improvements along a section of highway. Other factors considered were moose population and weather. The weather component included precipitation, snowfall, and maximum snow depth.

The purpose of a multiple regression analysis is to predict a single variable from one or more independent variables. To determine whether there is a significant relationship between the number of reported MVCs and the independent variables, assume the following null hypothesis (H_0), where H_0: The number of reported MVCs is independent of the independent variables.

H_0: β1=β2=β3=β4=β5=β6=0

H_a: At least one β_i does not equal 0

To determine whether a significant linear relationship could be detected between number of reported collisions, construction improvements, moose population, and weather, a regression analysis was performed. The dependent or predictor variable is the number of reported collisions. The independent or explanatory variables are construction improvements, moose population, and weather. The regression analysis is run, and the regression statistics are evaluated. The closer the *r*-squared value is to 1, the better the regression function fits the data. To check the results for statistical significance, the significance *F* is evaluated. Values of *F* less than 0.05 indicate reliable or statistically significant data. A variable with a high *p*-value (greater than 0.05) is an indication of unreliability and consequently is removed from the data set. The regression is rerun until significance *F* drops below 0.05.

The regression function is represented by Equation 1, where α and β are the least-squares solutions to several simultaneous linear equations, x_1 through x_k are independent variables, and *y* is the dependent variable (or predictor variable) (Dowdy, Wearden, & Chilko, 2004).

$$\boldsymbol{y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \varepsilon} \qquad \text{Equation 1}$$

The number of variables in each analysis was either five or six. The number of possible combinations of variables is represented by Equation 2, the number of combinations of *n* things taken *r* variables at a time (Dowdy, Wearden, & Chilko, 2004).

$$\binom{n}{r} = \frac{n!}{r!(n-r)!} \qquad \textbf{Equation 2}$$

Chapter 5 Data Analysis

Based on data collected, each project corridor had a different number of variables due to the types of improvements performed during construction. To determine how each variable interacts with the others in influencing the number of MVCs, numerous analyses were performed for each project to capture each variable combination. Table 3 lists the variables and symbols based on Equation 1 by each project road segment.

The independent variables related to the construction improvement were Clearing and Grubbing, Continuous Lighting, and Clearing. Additional independent variables analyzed included moose populations, precipitation, snowfall, and maximum snow depth.

Seven of the project corridors had five independent variables associated with the project corridor:

- Sterling Highway MP 82.0–93.72,
- Kalifornsky Beach Road MP 16.4–22.4,
- Glenn Highway MP 3.24–11.46,
- Glenn Highway MP 12.082–16.5,
- Parks Highway MP 37–39,
- Parks Highway MP 72–83, and
- Knik-Goose Bay Road MP 0.0–19.56.

The remaining three project corridors had six independent variables associated with the project corridor:

- Glenn Highway MP 4–11
- Glenn Highway MP 30.7–33.5
- Parks Highway MP 35–37

The last set of data analyzed was a combined set of all the project corridors. This set had seven independent variables.

Table 3. Variables by Project Road Segment

Road Segment	MP Est	Clearing and Grubbing	Continuous Lighting	Clearing	Moose Population - Linear	Precipitation (inches)	Snow Fall (inches)	Max Snow Depth (inches)
Sterling Highway	82.0-93.72	x_1	-	-	x_2	x_3	x_4	x_5
Kalifornsky Beach Road	MP 16.4-22.4	x_1	-	-	x_2	x_3	x_4	x_5
Glenn Highway	MP 4-11.	x_1	x_2	-	x_3	x_4	x_5	x_6
Glenn Highway	MP 3.24-11.46	-	x_1	-	x_2	x_3	x_4	x_5
Glenn Highway	MP 30.7-33.5	x_1	x_2	-	x_3	x_4	x_5	x_6
Glenn Highway	MP 12.082-16.5	-	x_1	-	x_2	x_3	x_4	x_5
Parks Highway	MP 35-37	x_1	x_2	-	x_3	x_4	x_5	x_6
Parks Highway	MP 37-39	x_1	-	-	x_2	x_3	x_4	x_5
Parks Highway	MP 72-83	-	-	x_1	x_2	x_3	x_4	x_5
Knik-Goose Bay Road	MP 0.0-19.56	x_1	-	-	x_2	x_3	x_4	x_5
Combined		x_1	x_2	x_3	x_4	x_5	x_6	x_7

Project corridor data sets with five independent variables were analyzed to determine whether there is a significant relationship between the number of reported moose-vehicle collisions (MVCs) and the independent variables. With five independent variables, *n*, the number of combinations of independent variables to analyze can be determined using Equation 2.

With five independent variables, *n*, the number of combinations of independent variables to analyze can be determined using Equation 2.

The number of combinations for five independent variables included, $r = 5$:

$$\binom{\mathbf{5}}{\mathbf{5}} = \frac{\mathbf{5!}}{\mathbf{5!\,(5-5)!}} = \frac{120}{120} = 1$$

The number of combinations for four independent variables included, $r = 4$:

$$\binom{\mathbf{5}}{\mathbf{4}} = \frac{\mathbf{5!}}{\mathbf{4!\,(5-4)!}} = \frac{120}{24} = 5$$

The number of combinations for three independent variables included, $r = 3$:

$$\binom{\mathbf{5}}{\mathbf{3}} = \frac{\mathbf{5!}}{\mathbf{3!\,(5-3)!}} = \frac{120}{12} = 10$$

The number of combinations for two independent variables included, $r = 2$:

$$\binom{\mathbf{5}}{\mathbf{2}} = \frac{\mathbf{5!}}{\mathbf{2!\,(5-2)!}} = \frac{120}{12} = 10$$

The number of combinations for one independent variables included, $r = 1$:

$$\binom{\mathbf{5}}{\mathbf{1}} = \frac{\mathbf{5!}}{\mathbf{1!\,(5-1)!}} = \frac{120}{24} = 5$$

In total, 31 different analyses were conducted for each of the seven project corridors with five independent variables. See Sections 5.1, 5.2, 5.4, 5.6, 5.8, 5.9, and 5.10 for results.

Project corridor data sets with six independent variables were analyzed to determine whether there is a significant relationship between the number of reported MVCs and the independent variables. With six independent variables, *n*, the number of combinations of independent variables to analyze can be determined using Equation 2.

The number of combinations for six independent variables included, $r = 6$:

$$\binom{6}{6} = \frac{6!}{6!\,(6-6)!} = \frac{720}{720} = 1$$

The number of combinations for five independent variables included, $r = 5$:

$$\binom{6}{5} = \frac{6!}{5!\,(6-5)!} = \frac{720}{120} = 6$$

The number of combinations for four independent variables included, $r = 4$:

$$\binom{6}{4} = \frac{6!}{4!\,(6-4)!} = \frac{720}{48} = 15$$

The number of combinations for three independent variables included, $r = 3$:

$$\binom{6}{3} = \frac{6!}{3!\,(6-3)!} = \frac{720}{36} = 20$$

The number of combinations for two independent variables included, $r = 2$:

$$\binom{6}{2} = \frac{6!}{2!\,(6-2)!} = \frac{720}{48} = 15$$

The number of combinations for one independent variables included, $r = 1$:

$$\binom{6}{1} = \frac{6!}{1!\,(6-1)!} = \frac{720}{120} = 6$$

In total, 63 different analyses were conducted for each of the three project corridors with five independent variables. See Sections 5.3, 5.5, and 5.7 for results.

All project corridors were included in a combined data set. This included projects with clearing and grubbing, continuous lighting, and clearing. Seven independent variables were analyzed to determine whether there is a significant relationship between the number of reported MVCs and the independent variables. With seven independent variables, *n*, the number of combinations of independent variables to analyze can be determined using Equation 2.

The number of combinations for seven independent variables included, *r* = 7:

$$\binom{7}{7} = \frac{7!}{7!\,(7-7)!} = \frac{5{,}040}{5{,}040} = 1$$

The number of combinations for six independent variables included, *r* = 6:

$$\binom{7}{6} = \frac{7!}{6!\,(7-6)!} = \frac{5{,}040}{720} = 7$$

The number of combinations for five independent variables included, *r* = 5:

$$\binom{7}{5} = \frac{7!}{5!\,(7-5)!} = \frac{5{,}040}{240} = 21$$

The number of combinations for four independent variables included, *r* = 4:

$$\binom{7}{4} = \frac{7!}{4!\,(7-4)!} = \frac{5{,}040}{144} = 35$$

The number of combinations for three independent variables included, *r* = 3:

$$\binom{7}{3} = \frac{7!}{3!\,(7-3)!} = \frac{5{,}040}{144} = 35$$

The number of combinations for two independent variables included, *r* = 2:

$$\binom{7}{2} = \frac{7!}{2!\,(7-2)!} = \frac{5{,}040}{240} = 21$$

The number of combinations for one independent variables included, *r* = 1:

$$\binom{7}{1} = \frac{7!}{1!\,(7-1)!} = \frac{5{,}040}{720} = 7$$

In total, 127 different analyses are possible based on the number of variable combinations for the combined data set. See Section 5.11 for the results of the analysis.

5.1 Sterling Highway Milepost (MP) 82.0–93.72

In total, 31 different analyses were conducted for the Sterling Highway MP 82.0–93.72 improvement project, which included the following independent variables: clearing and grubbing, moose population, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 4. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance F is greater than 0.05, and rejected if significance F is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 5 shows the results with significance F less than 0.05. The analysis with the highest correlation can be determined by looking at the adjusted r-squared (used when there is more than one independent variable) or r-squared (used when there is only one independent variable) value. The higher the adjusted r-squared or r-squared, the better the correlation. Set 31 has the highest correlation, with 40.9% of the variation in collisions explained by the independent variables. The resulting linear regression coefficients are provided in Table 6. Therefore, the relationship between the Number of Reported MVCs, y, and the independent variable, Maximum Snow Depth, x_5 (Clearing and Grubbing, x_1, Moose Population, x_2, Precipitation, x_3, and Snowfall, x_4, were not included in the set), is as follows:

$$\boldsymbol{y} = 2.7306 + (0.4290)\boldsymbol{x}_5$$

Table 4. Summary of Regression Analysis – Sterling Highway Milepost (MP) 82.0–93.72

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
5	Set 1	■	■	■	■	■	■	0.5764	-0.0876	N/A
4	Set 2	■	■	■	■	■		0.3769	0.1245	N/A
4	Set 3	■	■	■	■		■	0.4538	0.0358	N/A
4	Set 4	■	■	■		■	■	0.3987	0.0989	N/A
4	Set 5	■	■		■	■	■	0.3723	0.1299	N/A
4	Set 6	■		■	■	■	■	0.4543	0.0352	N/A
3	Set 7	■	■	■	■			0.4571	-0.0021	N/A
3	Set 8	■	■	■		■		0.2172	0.2479	N/A
3	Set 9	■	■	■			■	0.2593	0.1963	N/A
3	Set 10	■	■		■	■		0.2002	0.2702	N/A
3	Set 11	■	■		■		■	0.2783	0.1745	N/A
3	Set 12	■	■			■	■	0.2296	0.2322	N/A
3	Set 13	■		■	■	■		0.2735	0.1800	N/A
3	Set 14	■		■	■		■	0.2662	0.1883	N/A
3	Set 15	■		■		■	■	0.2625	0.1925	N/A
3	Set 16	■			■	■	■	0.3350	0.1138	N/A
2	Set 17	■	■	■				0.5939	-0.1079	N/A
2	Set 18	■	■		■			0.5249	-0.0695	N/A
2	Set 19	■	■			■		0.0970	0.3398	N/A
2	Set 20	■	■				■	0.1294	0.2831	N/A
2	Set 21	■		■	■			0.2836	0.1031	N/A
2	Set 22	■		■		■		0.1284	0.2847	N/A
2	Set 23	■		■			■	0.1177	0.3023	N/A
2	Set 24	■			■	■		0.2038	0.1839	N/A
2	Set 25	■			■		■	0.1585	0.2403	N/A
2	Set 26	■				■	■	0.1586	0.2403	N/A
1	Set 27	■	■					0.7656	N/A	0.0118
1	Set 28	■		■				0.2988	N/A	0.1337
1	Set 29	■			■			0.2399	N/A	0.1677
1	Set 30	■				■		0.0664	N/A	0.3606
1	Set 31	■					■	0.0464	N/A	0.4091

■ Variable included in the regression analysis
#.### Low statistical significance, significance $F > 0.05$

Table 5. Regression Analyses with Statistical Significance – Sterling Highway Milepost (MP) 82.0–93.72

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
1	Set 31							0.0464	N/A	0.4091
1	Set 30							0.0664	N/A	0.3606
2	Set 19							0.0970	0.3398	N/A
2	Set 23							0.1177	0.3023	N/A
2	Set 22							0.1284	0.2847	N/A
2	Set 20							0.1294	0.2831	N/A
2	Set 25							0.1585	0.2403	N/A
2	Set 26							0.1586	0.2403	N/A

Variable included in the regression analysis

#.### Low statistical significance, significance $F > 0.05$

Table 6. Set 31 Linear Regression Coefficients – Sterling Highway Milepost (MP) 82.0–93.72

	Coefficients
Intercept	2.7306
Max Snow Depth (inches)	0.4290

5.2 Kalifornsky Beach Road MP 16.4–22.4

In total, 31 different analyses were conducted for the Kalifornsky Beach Road MP 16.4–22.4 improvement project, which included the following independent variables: clearing and grubbing, moose populations, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 7. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance F is greater than 0.05, and rejected if significance F is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 8 shows the results with the lowest significance F and positive adjusted r-squared and r-squared values. The analysis with the highest correlation can be determined by looking at the adjusted r-squared (used when there is more than one independent variable) or r-squared (used when there is only one independent variable) value. The higher the adjusted r-squared or r-squared, the better the correlation. Set 28 has the highest correlation, with 26.2% of the variation in collisions explained by the independent variables. This is very low, and the set is not found to be statistically significant. Since the null hypothesis is accepted, it can be concluded that a relationship between the Number of Reported MVCs and the independent variables does not exist.

Although the null hypothesis is accepted, the resulting linear regression coefficients are provided in Table 9. Therefore, the relationship between the Number of Reported MVCs, y, and the independent variable, Moose Population, x_2 (Clearing and Grubbing, x_1, Precipitation, x_3, Snowfall, x_4, and Maximum Snow Depth, x_5, were not included in the set), is as follows:

$$\boldsymbol{y} = -21.6329 + (0.0313)\boldsymbol{x_2}$$

Table 7. Summary of Regression Analysis – Kalifornsky Beach Road MP 16.4–22.4

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
5	Set 1	■	■	■	■	■	■	0.8121	-0.4669	N/A
4	Set 2	■	■	■	■	■		0.7286	-0.2731	N/A
4	Set 3	■	■	■	■		■	0.6446	-0.1766	N/A
4	Set 4	■	■	■		■	■	0.6425	-0.1743	N/A
4	Set 5	■	■		■	■	■	0.7060	-0.2467	N/A
4	Set 6	■		■	■	■	■	0.6432	-0.1751	N/A
3	Set 7	■	■	■	■			0.5252	-0.0611	N/A
3	Set 8	■	■	■			■	0.4339	0.0187	N/A
3	Set 9	■	■			■	■	0.4992	-0.0389	N/A
3	Set 10	■			■	■	■	0.9011	-0.3714	N/A
3	Set 11	■	■	■		■		0.5391	-0.0727	N/A
3	Set 12	■	■		■	■		0.7122	-0.2130	N/A
3	Set 13	■		■	■	■		0.5647	-0.0940	N/A
3	Set 14	■	■		■		■	0.5119	-0.0497	N/A
3	Set 15	■		■	■		■	0.4351	0.0176	N/A
3	Set 16	■		■		■	■	0.4321	0.0203	N/A
2	Set 17	■	■	■				0.3096	0.0803	N/A
2	Set 18	■	■				■	0.2868	0.1002	N/A
2	Set 19	■				■	■	0.7327	-0.1764	N/A
2	Set 20	■	■		■			0.4844	-0.0452	N/A
2	Set 21	■		■	■			0.3322	0.0616	N/A
2	Set 22	■	■			■		0.4928	-0.0503	N/A
2	Set 23	■			■	■		0.8958	-0.2459	N/A
2	Set 24	■		■			■	0.2278	0.1575	N/A
2	Set 25	■			■		■	0.8169	-0.2135	N/A
2	Set 26	■		■		■		0.3444	0.0519	N/A
1	Set 27	■	■					0.2242	N/A	0.1783
1	Set 28	■		■				0.1306	N/A	0.2618
1	Set 29	■			■			0.7938	N/A	0.0090
1	Set 30	■				■		0.6751	N/A	0.0231
1	Set 31	■					■	0.5155	N/A	0.0547

■ Variable included in the regression analysis

#.#### Low statistical significance, significance $F > 0.05$

Table 8. Regression Analyses with Statistical Significance – Kalifornsky Beach Road MP 16.4–22.4

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
1	Set 28							0.1306	N/A	0.2618
1	Set 27							0.2242	N/A	0.1783
2	Set 24							0.2278	0.1575	N/A
2	Set 18							0.2868	0.1002	N/A
2	Set 17							0.3096	0.0803	N/A
2	Set 21							0.3322	0.0616	N/A
2	Set 26							0.3444	0.0519	N/A
3	Set 16							0.4321	0.0203	N/A
3	Set 8							0.4339	0.0187	N/A
3	Set 15							0.4351	0.0176	N/A
1	Set 31							0.5155	N/A	0.0547
1	Set 30							0.6751	N/A	0.0231
1	Set 29							0.7938	N/A	0.0090

Variable included in the regression analysis

Table 9. Set 28 Linear Regression Coefficients – Kalifornsky Beach Road MP 16.4–22.4

	Coefficients
Intercept	-21.6329
Moose Population - Linear	0.0313

5.3 Glenn Highway MP 4–11

In total, 63 different analyses were conducted for the Glenn Highway MP 4–11 improvement project, which included the following independent variables: clearing and grubbing, continuous lighting, moose population, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 10. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance F is greater than 0.05, and rejected if significance F is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 11 shows the results with significance F less than 0.05. The analysis with the highest correlation can be determined by looking at the adjusted r-squared (used when there is more than one independent variable) or r-squared (used when there is only one independent variable) value. The higher the adjusted r-squared or r-squared, the better the correlation. Set 43 has the highest correlation, with 22.0% of the variation in collisions explained by the independent variables. The resulting linear regression coefficients are provided in Table 12 through 14. Therefore, the relationship between the Number of Reported MVCs, y, and the independent variables, Clearing and Grubbing, x_1, and Continuous Lighting, x_2 (Moose Population, x_3, Precipitation, x_4, Snowfall, x_5, and Maximum Snow Depth, x_6, were not included in the set), is as follows:

$$\boldsymbol{y} = 30.8 + (0)\boldsymbol{x_1} + (-17.2)\boldsymbol{x_2}$$

The zero value coefficient for clearing and grubbing shows that this variable does not affect the Number of Reported MVCs, y. Therefore, the relationship is better defined by the data in set 58 or 59, where 41.8% of the variation in collisions is explained by the independent variables and is represented by the following equations, respectively:

$$\boldsymbol{y} = 30.8 + (-17.2)\boldsymbol{x_1}$$

$$\boldsymbol{y} = 30.8 + (-17.2)\boldsymbol{x_2}$$

From this set of data, it cannot be determined whether clearing or grubbing or continuous lighting has greater effect or equal effect on the outcome of MVCs.

Table 10. Summary of Regression Analysis – Glenn Highway MP 4–11

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
6	Set 1								0.3211	0.0814	N/A
5	Set 2								0.3335	0.0120	N/A
5	Set 3								0.5230	-0.2097	N/A
5	Set 4								0.2326	0.1476	N/A
5	Set 5								0.2838	0.0765	N/A
5	Set 6								0.2782	0.3314	N/A
5	Set 7								0.2782	0.3314	N/A
4	Set 8								0.3179	-0.0122	N/A
4	Set 9								0.2889	0.0186	N/A
4	Set 10								0.3426	-0.0371	N/A
4	Set 11								0.2810	0.0272	N/A
4	Set 12								0.3421	-0.0367	N/A
4	Set 13								0.1443	0.2085	N/A
4	Set 14								0.3050	0.2120	N/A
4	Set 15								0.4944	-0.0097	N/A
4	Set 16								0.2052	0.3476	N/A
4	Set 17								0.2556	0.2765	N/A
4	Set 18								0.3050	0.2120	N/A
4	Set 19								0.4944	-0.0097	N/A
4	Set 20								0.2052	0.3476	N/A
4	Set 21								0.2556	0.2765	N/A
4	Set 22								0.1894	0.3712	N/A
3	Set 23								0.1550	0.1090	N/A
3	Set 24								0.1536	0.1110	N/A
3	Set 25								0.1213	0.1579	N/A
3	Set 26								0.1540	0.1104	N/A
3	Set 27								0.2965	0.1544	N/A
3	Set 28								0.2689	0.1852	N/A
3	Set 29								0.3198	0.1295	N/A
3	Set 30								0.2614	0.1938	N/A
3	Set 31								0.3193	0.1300	N/A
3	Set 32								0.1309	0.3752	N/A
3	Set 33								0.2965	0.1544	N/A

Table 10. Summary of Regression Analysis – Glenn Highway MP 4–11 (Continued)

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
3	Set 34	■		■	■		■		0.2689	0.1852	N/A
3	Set 35	■		■	■			■	0.3198	0.1295	N/A
3	Set 36	■		■		■	■		0.2614	0.1938	N/A
3	Set 37	■		■		■		■	0.3193	0.1300	N/A
3	Set 38	■		■			■	■	0.1309	0.3752	N/A
3	Set 39	■			■	■	■		0.2016	0.2684	N/A
3	Set 40	■			■	■		■	0.2928	0.1584	N/A
3	Set 41	■			■		■	■	0.0899	0.4539	N/A
3	Set 42	■				■	■	■	0.2464	0.2116	N/A
2	Set 43	■	■	■					0.0334	0.2202	N/A
2	Set 44	■	■		■				0.1503	0.2519	N/A
2	Set 45	■	■			■			0.1489	0.2538	N/A
2	Set 46	■	■				■		0.1187	0.3007	N/A
2	Set 47	■	■					■	0.1493	0.2532	N/A
2	Set 48	■		■	■				0.1503	0.2519	N/A
2	Set 49	■		■		■			0.1489	0.2538	N/A
2	Set 50	■		■			■		0.1187	0.3007	N/A
2	Set 51	■		■				■	0.1493	0.2532	N/A
2	Set 52	■			■	■			0.1350	0.2744	N/A
2	Set 53	■			■		■		0.2189	0.1671	N/A
2	Set 54	■			■			■	0.4132	0.0012	N/A
2	Set 55	■				■	■		0.2249	0.1605	N/A
2	Set 56	■				■		■	0.4562	-0.0275	N/A
2	Set 57	■					■	■	0.1079	0.3194	N/A
1	Set 58	■	■						0.0434	N/A	0.4179
1	Set 59	■		■					0.0434	N/A	0.4179
1	Set 60	■			■				0.1685	N/A	0.2227
1	Set 61	■				■			0.2685	N/A	0.1502
1	Set 62	■					■		0.1493	N/A	0.2413
1	Set 63	■						■	0.7007	N/A	0.0195

■ Variable included in the regression analysis

#.#### Low statistical significance, significance $F > 0.05$

Table 11. Regression Analyses with Statistical Significance – Glenn Highway MP 4–11

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance F	Adjusted *r*-squared	*r*-squared
2	Set 43	■	■	■					0.0334	0.2202	N/A
1	Set 58	■	■						0.0434	N/A	0.4179
1	Set 59	■		■					0.0434	N/A	0.4179

■ Variable included in the regression analysis

Table 12. Set 43 Linear Regression Coefficients – Glenn Highway MP 4–11

	Coefficients
Intercept	30.8
Clearing and Grubbing	0
Continuous Lighting	-17.2

Table 13. Set 58 Linear Regression Coefficients – Glenn Highway MP 4–11

	Coefficients
Intercept	30.8
Clearing and Grubbing	-17.2

Table 14. Set 59 Linear Regression Coefficients – Glenn Highway MP 4–11

	Coefficients
Intercept	30.8
Continuous Lighting	-17.2

5.4 Glenn Highway MP 3.24–11.46

In total, 31 different analyses were conducted for the Glenn Highway MP 3.24–11.46 improvement project, which included the following independent variables: continuous lighting, moose population, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 15. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance F is greater than 0.05, and rejected if significance F is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 16 shows the results with significance F less than 0.05. The analysis with the highest correlation can be determined by looking at the adjusted r-squared (used when there is more than one independent variable) or r-squared (used when there is only one independent variable) value. The higher the adjusted r-squared or r-squared, the better the correlation. Set 19 has the highest correlation, with 52.3% of the variation in collisions explained by the independent variables. The resulting linear regression coefficients are provided in Table 17. Therefore, the relationship between the Number of Reported MVCs, y, and the independent variables, Continuous Lighting, x_1 and Snowfall, x_4 (Moose Population, x_2, Precipitation, x_3, and Maximum Snow Depth, x_5, were not included in the set), is as follows:

$$\boldsymbol{y} = 24.3006 + (5.9046)\boldsymbol{x_1} + (-0.1753)\boldsymbol{x_4}$$

Table 15. Summary of Regression Analysis – Glenn Highway MP 3.24–11.46

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
5	Set 1							0.2196	0.4198	N/A
4	Set 2							0.1148	0.4987	N/A
4	Set 3							0.2700	0.2572	N/A
4	Set 4							0.1539	0.4282	N/A
4	Set 5							0.0967	0.5353	N/A
4	Set 6							0.2329	0.3076	N/A
3	Set 7							0.5811	-0.1075	N/A
3	Set 8							0.0931	0.4470	N/A
3	Set 9							0.1276	0.3810	N/A
3	Set 10							0.0446	0.5733	N/A
3	Set 11							0.1589	0.3297	N/A
3	Set 12							0.0616	0.5224	N/A
3	Set 13							0.1084	0.4161	N/A
3	Set 14							0.4365	0.0164	N/A
3	Set 15							0.2164	0.2489	N/A
3	Set 16							0.1933	0.2796	N/A
2	Set 17							0.3698	0.0324	N/A
2	Set 18							0.3785	0.0259	N/A
2	Set 19							0.0312	0.5226	N/A
2	Set 20							0.0598	0.4250	N/A
2	Set 21							0.8962	-0.2461	N/A
2	Set 22							0.1059	0.3230	N/A
2	Set 23							0.2311	0.1540	N/A
2	Set 24							0.0947	0.3444	N/A
2	Set 25							0.2472	0.1375	N/A
2	Set 26							0.1550	0.2453	N/A
1	Set 27							0.1676	N/A	0.2235
1	Set 28							0.6626	N/A	0.0250
1	Set 29							0.9112	N/A	0.0017
1	Set 30							0.0751	N/A	0.3433
1	Set 31							0.0864	N/A	0.3232

	Variable included in the regression analysis
#.####	Low statistical significance, significance $F > 0.05$

Table 16. Regression Analyses with Statistical Significance – Glenn Highway MP 3.24–11.46

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
2	Set 19					-		0.0312	0.5226	N/A
3	Set 10					-		0.0446	0.5733	N/A
2	Set 20						-	0.0598	0.4250	N/A
3	Set 12							0.0616	0.5224	N/A
1	Set 30							0.0751	N/A	0.3433
1	Set 31							0.0864	N/A	0.3232

Variable included in the regression analysis

Table 17. Set 19 Linear Regression Coefficients – Glenn Highway MP 3.24–11.46

	Coefficients
Intercept	24.3006
Continuous Lighting	5.9046
Snowfall (inches)	-0.1753

5.5 Glenn Highway MP 30.7–33.5

In total, 63 different analyses were conducted for the Glenn Highway MP 30.7–33.5 improvement project, which included the following independent variables: clearing and grubbing, continuous lighting, moose population, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 18. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance *F* is greater than 0.05, and rejected if significance *F* is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 19 shows the results with significance *F* less than 0.05. The analysis with the highest correlation can be determined by looking at the adjusted *r*-squared (used when there is more than one independent variable) or *r*-squared (used when there is only one independent variable) value. The higher the adjusted *r*-squared or *r*-squared, the better the correlation. Sets 31 and 37 have the highest correlation, with 85.9% of the variation in collisions explained by the independent variables. The resulting linear regression coefficients are provided in Table 20 and Table 21. Therefore, the relationship between the Number of Reported MVCs, *y*, and the independent variables, Clearing and Grubbing, x_1, Continuous Lighting, x_2, Precipitation, x_4, and Maximum Snow Depth, x_6 (Moose Population, x_3, and Snowfall, x_5, were not included in the set), is as follows for Sets 31 and 37, respectively:

$$\boldsymbol{y} = 1.3096 + (-3.8894)\boldsymbol{x_1} + (0.4548)\boldsymbol{x_4} + (-0.1624)\boldsymbol{x_6}$$

$$\boldsymbol{y} = 1.3096 + (-3.8894)\boldsymbol{x_2} + (0.4548)\boldsymbol{x_4} + (-0.1624)\boldsymbol{x_6}$$

Table 18. Summary of Regression Analysis – Glenn Highway MP 30.7–33.5

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
6	Set 1								0.0404	0.5900	N/A
5	Set 2								0.0267	0.5810	N/A
5	Set 3								0.0141	0.6408	N/A
5	Set 4								0.0858	0.4069	N/A
5	Set 5								0.0091	0.6720	N/A
5	Set 6								0.0206	0.8400	N/A
5	Set 7								0.0206	0.8400	N/A
4	Set 8								0.0760	0.3438	N/A
4	Set 9								0.0509	0.4132	N/A
4	Set 10								0.0313	0.4847	N/A
4	Set 11								0.0344	0.4722	N/A
4	Set 12								0.0031	0.6919	N/A
4	Set 13								0.0279	0.4998	N/A
4	Set 14								0.0165	0.7810	N/A
4	Set 15								0.0076	0.8408	N/A
4	Set 16								0.0658	0.6069	N/A
4	Set 17								0.0045	0.8720	N/A
4	Set 18								0.0165	0.7810	N/A
4	Set 19								0.0076	0.8408	N/A
4	Set 20								0.0658	0.6069	N/A
4	Set 21								0.0045	0.8720	N/A
4	Set 22								0.0574	0.6294	N/A
3	Set 23								0.0208	0.4351	N/A
3	Set 24								0.1767	0.0818	N/A
3	Set 25								0.1467	0.1203	N/A
3	Set 26								0.0132	0.4887	N/A
3	Set 27								0.0660	0.5104	N/A
3	Set 28								0.0427	0.5799	N/A
3	Set 29								0.0249	0.6514	N/A
3	Set 30								0.0276	0.6388	N/A
3	Set 31								0.0018	0.8585	N/A
3	Set 32								0.0220	0.6664	N/A
3	Set 33								0.0660	0.5104	N/A

Table 18. Summary of Regression Analysis – Glenn Highway MP 30.7–33.5 (Continued)

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance F	Adjusted r-squared	r-squared
3	Set 34	■		■	■		■		0.0427	0.5799	N/A
3	Set 35	■		■	■			■	0.0249	0.6514	N/A
3	Set 36	■		■		■	■		0.0276	0.6388	N/A
3	Set 37	■		■		■		■	0.0018	0.8585	N/A
3	Set 38	■		■			■	■	0.0220	0.6664	N/A
3	Set 39	■			■	■	■		0.0178	0.6894	N/A
3	Set 40	■			■	■		■	0.0312	0.6233	N/A
3	Set 41	■			■		■	■	0.0330	0.6158	N/A
3	Set 42	■				■	■	■	**0.3631**	0.0856	N/A
2	Set 43	■	■	■					0.0498	0.1688	N/A
2	Set 44	■	■		■				0.0203	0.5780	N/A
2	Set 45	■	■			■			**0.1703**	0.2247	N/A
2	Set 46	■	■				■		**0.1425**	0.2632	N/A
2	Set 47	■	■					■	0.0126	0.6316	N/A
2	Set 48	■		■	■				0.0203	0.5780	N/A
2	Set 49	■		■		■			**0.1703**	0.2247	N/A
2	Set 50	■		■			■		**0.1425**	0.2632	N/A
2	Set 51	■		■				■	0.0126	0.6316	N/A
2	Set 52	■			■	■			0.0199	0.5801	N/A
2	Set 53	■			■		■		0.0117	0.6390	N/A
2	Set 54	■			■			■	0.0087	0.6682	N/A
2	Set 55	■				■	■		**0.6870**	-0.1549	N/A
2	Set 56	■				■		■	**0.2706**	0.1150	N/A
2	Set 57	■					■	■	**0.2839**	0.1028	N/A
1	Set 58	■	■						**0.0610**	N/A	0.3723
1	Set 59	■		■					**0.0610**	N/A	0.3723
1	Set 60	■			■				0.0037	N/A	0.6716
1	Set 61	■				■			**0.4352**	N/A	0.0778
1	Set 62	■					■		**0.3947**	N/A	0.0918
1	Set 63	■						■	**0.1066**	N/A	0.2924

■	Variable included in the regression analysis
#.####	Low statistical significance, significance $F > 0.05$

Table 19. Regression Analyses with Statistical Significance – Glenn Highway MP 30.7–33.5

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
3	Set 31	■	■			■		■	0.0018	0.8585	N/A
3	Set 37	■		■		■		■	0.0018	0.8585	N/A
4	Set 12	■	■	■		■		■	0.0031	0.6919	N/A
1	Set 60	■			■				0.0037	N/A	0.6716
4	Set 17	■	■			■	■	■	0.0045	0.8720	N/A
4	Set 21	■		■		■	■	■	0.0045	0.8720	N/A
4	Set 15	■	■		■	■		■	0.0076	0.8408	N/A
4	Set 19	■		■	■	■		■	0.0076	0.8408	N/A
2	Set 54	■			■			■	0.0087	0.6682	N/A
5	Set 5	■	■	■		■	■	■	0.0091	0.6720	N/A

■ Variable included in the regression analysis

Table 20. Set 31 Linear Regression Coefficients – Glenn Highway MP 30.7–33.5

	Coefficients
Intercept	1.3096
Clearing and Grubbing	-3.8894
Precipitation (inches)	0.4548
Max Snow Depth (inches)	-0.1624

Table 21. Set 37 Linear Regression Coefficients – Glenn Highway MP 30.7–33.5

	Coefficients
Intercept	1.3096
Continuous Lighting	-3.8894
Precipitation (inches)	0.4548
Max Snow Depth (inches)	-0.1624

5.6 Glenn Highway MP 12.082–16.5

In total, 31 different analyses were conducted for the Glenn Highway MP 12.082–16.5 improvement project, which included the following independent variables: continuous lighting, moose populations, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 22. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance *F* is greater than 0.05, and rejected if significance *F* is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 23 shows the results with significance *F* less than 0.05. The analysis with the highest correlation can be determined by looking at the adjusted *r*-squared (used when there is more than one independent variable) or *r*-squared (used when there is only one independent variable) value. The higher the adjusted *r*-squared or *r*-squared, the better the correlation. Set 28 has the highest correlation, with 65.2% of the variation in collisions explained by the independent variables. The resulting linear regression coefficients are provided in Table 24. Therefore, the relationship between the Number of Reported MVCs, y, and the independent variables Moose Population, x_2 (Continuous Lighting, x_1, Precipitation, x_3, Snowfall, x_4, and Maximum Snow Depth, x_5, were not included in the set), is as follows:

$$\boldsymbol{y} = -14.8503 + (0.0109)\boldsymbol{x_2}$$

The positive coefficient associated with Moose Population indicates that MVCs will rise and fall with changes in population.

Table 22. Summary of Regression Analysis – Glenn Highway MP 12.082–16.5

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
5	Set 1							0.0778	0.6764	N/A
4	Set 2							0.0874	0.5553	N/A
4	Set 3							0.0379	0.6897	N/A
4	Set 4							0.1603	0.4175	N/A
4	Set 5							0.6012	-0.1282	N/A
4	Set 6							0.0331	0.7069	N/A
3	Set 7							0.0360	0.6042	N/A
3	Set 8							0.0755	0.4867	N/A
3	Set 9							0.0768	0.4837	N/A
3	Set 10							0.5108	-0.0488	N/A
3	Set 11							0.4054	0.0450	N/A
3	Set 12							0.5544	-0.0854	N/A
3	Set 13							0.0302	0.6275	N/A
3	Set 14							0.0126	0.7245	N/A
3	Set 15							0.0685	0.5041	N/A
3	Set 16							0.9743	-0.4499	N/A
2	Set 17							0.0241	0.5565	N/A
2	Set 18							0.3322	0.0616	N/A
2	Set 19							0.3536	0.0447	N/A
2	Set 20							0.3339	0.0602	N/A
2	Set 21							0.0095	0.6599	N/A
2	Set 22							0.0239	0.5574	N/A
2	Set 23							0.0247	0.5533	N/A
2	Set 24							0.8897	-0.2435	N/A
2	Set 25							0.9075	-0.2505	N/A
2	Set 26							0.9804	-0.2785	N/A
1	Set 27							0.1388	N/A	0.2526
1	Set 28							0.0047	N/A	0.6524
1	Set 29							0.7660	N/A	0.0117
1	Set 30							0.8771	N/A	0.0032
1	Set 31							0.9542	N/A	0.0004

	Variable included in the regression analysis
#.####	Low statistical significance, significance $F > 0.05$

Table 23. Regression Analyses with Statistical Significance – Glenn Highway MP 12.082–16.5

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
1	Set 28	■		■				0.0047	N/A	0.6524
2	Set 21	■		■	■			0.0095	0.6599	N/A
3	Set 14	■		■	■		■	0.0126	0.7245	N/A
2	Set 22	■		■		■		0.0239	0.5574	N/A
2	Set 17	■	■	■				0.0241	0.5565	N/A
2	Set 23	■		■			■	0.0247	0.5533	N/A
3	Set 13	■		■	■	■		0.0302	0.6275	N/A
4	Set 6	■		■	■	■	■	0.0331	0.7069	N/A
3	Set 7	■	■	■	■			0.0360	0.6042	N/A
4	Set 3	■	■	■	■		■	0.0379	0.6897	N/A

■ Variable included in the regression analysis

Table 24. Set 28 Linear Regression Coefficients – Glenn Highway MP 12.082–16.5

	Coefficients
Intercept	-14.8503
Moose Population - Linear	0.0109

5.7 Parks Highway MP 35–37

In total, 63 different analyses were conducted for the Parks Highway MP 35–37 improvement project, which included the following independent variables: clearing and grubbing, continuous lighting, moose population, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 25. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance *F* is greater than 0.05, and rejected if significance *F* is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 26 shows the results of the analysis with the lowest significance *F*. No set of data resulted in a significance *F* less than 0.05. The null hypothesis is accepted, the number of reported MVCs is independent of the independent variables, or the set is inconclusive. Set 41 has the highest correlation, with 79.5% of the variation in collisions explained by the independent variables. The resulting linear regression coefficients are provided in Table 27. Therefore, the relationship between the Number of Reported MVCs, y, and the independent variables: Moose Population, x_3, Snowfall, x_5, and Maximum Snow Depth, x_6 (Clearing and Grubbing, x_1,Continuous Lighting, x_2, and Precipitation, x_4 were not included in the set), is as follows:

$$\boldsymbol{y} = -3.4721 + (0.0004)\boldsymbol{x_3} + (0.0457)\boldsymbol{x_5} + (-0.0768)\boldsymbol{x_6}$$

Table 25. Summary of Regression Analysis – Parks Highway MP 35–37

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
6	Set 1								0.0695	0.7998	N/A
5	Set 2								0.2354	0.3954	N/A
5	Set 3								0.2315	0.4014	N/A
5	Set 4								0.0177	0.8518	N/A
5	Set 5								0.0413	0.7695	N/A
5	Set 6								0.0196	0.8438	N/A
5	Set 7								0.0225	0.8324	N/A
4	Set 8								0.1652	0.4095	N/A
4	Set 9								0.4362	0.0557	N/A
4	Set 10								0.9565	-0.6106	N/A
4	Set 11								0.2298	0.3120	N/A
4	Set 12								0.2645	0.2645	N/A
4	Set 13								0.0621	0.6167	N/A
4	Set 14								0.1468	0.4403	N/A
4	Set 15								0.1644	0.4107	N/A
4	Set 16								0.0066	0.8496	N/A
4	Set 17								0.0282	0.7262	N/A
4	Set 18								0.2477	0.2872	N/A
4	Set 19								0.2762	0.2491	N/A
4	Set 20								0.0196	0.7647	N/A
4	Set 21								0.0328	0.7082	N/A
4	Set 22								0.0175	0.7756	N/A
3	Set 23								0.8521	-0.3276	N/A
3	Set 24								0.1282	0.3799	N/A
3	Set 25								0.2423	0.2165	N/A
3	Set 26								0.8101	-0.2922	N/A
3	Set 27								0.0698	0.5007	N/A
3	Set 28								0.2790	0.1737	N/A
3	Set 29								0.9275	-0.3969	N/A
3	Set 30								0.1090	0.4150	N/A
3	Set 31								0.1295	0.3775	
3	Set 32								0.0224	0.6640	N/A
3	Set 33								0.1005	0.4317	N/A

Table 25. Summary of Regression Analysis – Parks Highway MP 35–37 (Continued)

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance F	Adjusted r-squared	r-squared
3	Set 34								0.2760	0.1771	N/A
3	Set 35								0.8647	-0.3386	N/A
3	Set 36								0.1162	0.4015	N/A
3	Set 37								0.1384	0.3624	N/A
3	Set 38								0.0274	0.6400	N/A
3	Set 39								0.1147	0.4042	N/A
3	Set 40								0.1315	0.3741	N/A
3	Set 41								0.0053	0.7949	N/A
3	Set 42								0.0088	0.7557	N/A
2	Set 43								0.7702	-0.1933	N/A
2	Set 44								0.7976	-0.2053	N/A
2	Set 45								0.0663	0.4078	N/A
2	Set 46								0.1241	0.2917	N/A
2	Set 47								0.7849	-0.1997	N/A
2	Set 48								0.7705	-0.1934	N/A
2	Set 49								0.0614	0.4207	N/A
2	Set 50								0.1532	0.2477	N/A
2	Set 51								0.8273	-0.2179	N/A
2	Set 52								0.0628	0.4169	N/A
2	Set 53								0.1361	0.2727	N/A
2	Set 54								0.8168	-0.2135	N/A
2	Set 55								0.0415	0.4819	N/A
2	Set 56								0.0501	0.4533	N/A
2	Set 57								0.0074	0.6834	N/A
1	Set 58								0.4860	N/A	0.0625
1	Set 59								0.6184	N/A	0.0325
1	Set 60								0.5796	N/A	0.0400
1	Set 61								0.0173	N/A	0.5278
1	Set 62								0.0446	N/A	0.4144
1	Set 63								0.8619	N/A	0.0040

	Variable included in the regression analysis
#.####	Low statistical significance, Significance $F > 0.05$

Table 26. Regression Analyses with Statistical Significance – Parks Highway MP 35–37

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Continuous Lighting	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
3	Set 41	■			■		■	■	0.0053	0.7949	N/A
4	Set 16	■	■		■		■	■	0.0066	0.8496	N/A
2	Set 57	■					■	■	0.0074	0.6834	N/A
3	Set 42	■				■	■	■	0.0088	0.7557	N/A
1	Set 61	■				■			0.0173	N/A	0.5278
4	Set 22	■			■	■	■	■	0.0175	0.7756	N/A
5	Set 4	■	■	■	■		■	■	0.0177	0.8518	N/A
5	Set 6	■	■		■	■	■	■	0.0196	0.8438	N/A
4	Set 20	■		■	■		■	■	0.0196	0.7647	N/A

■ Variable included in the regression analysis

Table 27. Set 41 Linear Regression Coefficients – Parks Highway MP 35–37

	Coefficients
Intercept	-3.4721
Moose Population - Linear	0.0004
Snowfall (inches)	0.0457
Max Snow Depth (inches)	-0.0768

5.8 Parks Highway MP 37–39

In total, 31 different analyses were conducted for the Parks Highway MP 37–39 improvement project, which included the following independent variables: clearing and grubbing, moose population, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 28. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance *F* is greater than 0.05, and rejected if significance *F* is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 29 shows the results of the analysis with the lowest significance *F*. No set of data resulted in a significance *F* less than 0.05. The null hypothesis is accepted, the number of reported MVCs is independent of the independent variables, or the set is inconclusive. Set 22 has the highest correlation, with 16.7% of the variation in collisions explained by the independent variables. The resulting linear regression coefficients are provided in Table 30. Since the null hypothesis is accepted, it can be concluded that a relationship between the Number of Reported MVCs and the independent variables does not exist. The resulting linear regression coefficients are provided in Table 30.

Although the null hypothesis is accepted, the relationship between the Number of Reported MVCs, y, and the independent variables Moose Population, x_2, and Snowfall, x_4, (Clearing and Grubbing, x_1, Precipitation, x_3, and Maximum Snow Depth, x_5 were not included in the set), for Set 22 is as follows:

$$\boldsymbol{y} = 9.0601 + (-0.0015)\boldsymbol{x_2} + (0.0281)\boldsymbol{x_4}$$

Table 28. Summary of Regression Analysis – Parks Highway MP 37–39

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance F	Adjusted r-squared	r-squared
5	Set 1	■	■	■	■	■	■	0.7574	-0.3678	N/A
4	Set 2	■	■	■	■	■		0.5865	-0.1119	N/A
4	Set 3	■	■	■	■		■	0.7626	-0.3140	N/A
4	Set 4	■	■	■		■	■	0.5734	-0.0973	N/A
4	Set 5	■	■		■	■	■	0.6391	-0.1704	N/A
4	Set 6	■		■	■	■	■	0.6288	-0.1590	N/A
3	Set 7	■	■	■	■			0.6903	-0.1955	N/A
3	Set 8	■	■	■		■		0.3760	0.0729	N/A
3	Set 9	■	■	■			■	0.5972	-0.1206	N/A
3	Set 10	■	■		■	■		0.5745	-0.1021	N/A
3	Set 11	■	■		■		■	0.8840	-0.3556	N/A
3	Set 12	■	■			■	■	0.4488	0.0053	N/A
3	Set 13	■		■	■	■		0.4238	0.0279	N/A
3	Set 14	■		■	■		■	0.5698	-0.0982	N/A
3	Set 15	■		■		■	■	0.4171	0.0341	N/A
3	Set 16	■			■	■	■	0.8290	-0.3080	N/A
2	Set 17	■	■	■				0.5198	-0.0665	N/A
2	Set 18	■	■		■			0.7161	-0.1687	N/A
2	Set 19	■	■			■		0.3558	0.0430	N/A
2	Set 20	■	■				■	0.7162	-0.1688	N/A
2	Set 21	■		■	■			0.4733	-0.0383	N/A
2	Set 22	■		■		■		0.2191	0.1668	N/A
2	Set 23	■		■			■	0.3654	0.0357	N/A
2	Set 24	■			■	■		0.6221	-0.1227	N/A
2	Set 25	■			■		■	0.8898	-0.2435	N/A
2	Set 26	■				■	■	0.6425	-0.1331	N/A
1	Set 27	■	■					0.4236	N/A	0.1187
1	Set 28	■		■				0.2548	N/A	0.1583
1	Set 29	■			■			0.8481	N/A	0.0049
1	Set 30	■				■		0.3316	N/A	0.1178
1	Set 31	■					■	0.6208	N/A	0.0320

■ Variable included in the regression analysis

#.#### Low statistical significance, significance $F > 0.05$

Table 29. Regression Analyses with Statistical Significance – Parks Highway MP 37–39

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
2	Set 22	■		■		■		0.2191	0.1668	N/A
1	Set 28	■		■				0.2548	N/A	0.1583
1	Set 27	■	■					0.4236	N/A	0.1187
1	Set 30	■				■		0.3316	N/A	0.1178
3	Set 8	■	■	■		■		0.3760	0.0729	N/A
2	Set 19	■	■			■		0.3558	0.0430	N/A
2	Set 23	■		■			■	0.3654	0.0357	N/A
3	Set 15	■		■		■	■	0.4171	0.0341	N/A
1	Set 31	■					■	0.6208	N/A	0.0320
3	Set 13	■		■	■	■		0.4238	0.0279	N/A
3	Set 12	■	■			■	■	0.4488	0.0053	N/A
1	Set 29	■			■			0.8481	N/A	0.0049

■ Variable included in the regression analysis

Table 30. Set 22 Linear Regression Coefficients – Parks Highway MP 37–39

	Coefficients
Intercept	9.0601
Moose Population - Linear	-0.0015
Snowfall (inches)	0.0281

5.9 Parks Highway MP 72–83

In total, 31 different analyses were conducted for the Parks Highway MP 72–83 improvement project, which included the following independent variables clearing, moose population, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 31. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance *F* is greater than 0.05, and rejected if significance *F* is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 32 shows the results of the analysis with the lowest significance *F*. No set of data resulted in a significance *F* less than 0.05. The null hypothesis is accepted, the number of reported MVCs is independent of the independent variables, or the set is inconclusive. Set 25 has the highest correlation, with 35.8% of the variation in collisions explained by the independent variables. The resulting linear regression coefficients are provided in Table 33. Since the null hypothesis is accepted, it can be concluded that a relationship between the Number of Reported MVCs and the independent variables does not exist. The resulting linear regression coefficients are provided in Table 33.

Although the null hypothesis is accepted, the relationship between the Number of Reported MVCs, y, and the independent variables Precipitation, x_3 and Maximum Snow Depth, x_5 (Clearing, x_1, Moose Population, x_2, and Snowfall, x_4 were not included in the set), for Set 25 is as follows:

$$\boldsymbol{y} = 12.8091 + (-1.3763)\boldsymbol{x_3} + (0.6640)\boldsymbol{x_5}$$

Table 31. Summary of Regression Analysis – Parks Highway MP 72–83

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
5	Set 1	■	■	■	■	■	■	0.5800	0.1982	N/A
4	Set 2	■	■	■	■	■		0.2494	0.5991	N/A
4	Set 3	■	■	■	■		■	0.5517	0.0088	N/A
4	Set 4	■	■	■		■	■	0.8272	-0.7529	N/A
4	Set 5	■	■		■	■	■	0.6490	-0.2226	N/A
4	Set 6	■		■	■	■	■	0.6558	-0.2400	N/A
3	Set 7	■	■	■	■			0.2972	0.3244	N/A
3	Set 8	■	■	■		■		0.6091	-0.1723	N/A
3	Set 9	■	■	■			■	0.6973	-0.3152	N/A
3	Set 10	■	■		■	■		0.6728	-0.2749	N/A
3	Set 11	■	■		■		■	0.3936	0.1679	N/A
3	Set 12	■	■			■	■	0.7210	-0.3547	N/A
3	Set 13	■		■	■	■		0.7070	-0.3314	N/A
3	Set 14	■		■	■		■	0.4077	0.1455	N/A
3	Set 15	■		■		■	■	0.6421	-0.2250	N/A
3	Set 16	■			■	■	■	0.3967	0.1629	N/A
2	Set 17	■	■	■				0.4440	0.0005	N/A
2	Set 18	■	■		■			0.4818	-0.0412	N/A
2	Set 19	■	■			■		0.6503	-0.2096	N/A
2	Set 20	■	■				■	0.4676	-0.0257	N/A
2	Set 21	■		■	■			0.4785	-0.0376	N/A
2	Set 22	■		■		■		0.4937	-0.0539	N/A
2	Set 23	■		■			■	0.4327	0.0133	N/A
2	Set 24	■			■	■		0.4643	#REF!	N/A
2	Set 25	■			■		■	0.1833	0.3577	N/A
2	Set 26	■				■	■	0.9646	-0.4732	N/A
1	Set 27	■	■					0.3681	N/A	0.1636
1	Set 28	■		■				0.2067	N/A	0.2961
1	Set 29	■			■			0.2505	N/A	0.2525
1	Set 30	■				■		0.8167	N/A	0.0118
1	Set 31	■					■	0.7757	N/A	0.0178

■ Variable included in the regression analysis
#.#### Low statistical significance, significance $F > 0.05$

Table 32. Regression Analyses with Statistical Significance – Parks Highway MP 72–83

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
2	Set 25							0.1833	0.3577	N/A
1	Set 28							0.2067	N/A	0.2961
4	Set 2							0.2494	0.5991	N/A
1	Set 29							0.2505	N/A	0.2525
3	Set 7							0.2972	0.3244	N/A
1	Set 27							0.3681	N/A	0.1636
3	Set 11							0.3936	0.1679	N/A
3	Set 16							0.3967	0.1629	N/A
3	Set 14							0.4077	0.1455	N/A
2	Set 23							0.4327	0.0133	N/A
2	Set 17							0.4440	0.0005	N/A
4	Set 3							0.5517	0.0088	N/A
5	Set 1							0.5800	0.1982	N/A
1	Set 31							0.7757	N/A	0.0178
1	Set 30							0.8167	N/A	0.0118

Variable included in the regression analysis

#.#### Low statistical significance, significance $F > 0.05$

Table 33. Set 25 Linear Regression Coefficients – Parks Highway MP 72–83

	Coefficients
Intercept	12.8091
Precipitation (inches)	-1.3763
Max Snow Depth (inches)	0.6640

5.10 Knik-Goose Bay Road MP 0.0–19.56

In total, 31 different analyses were conducted for the Knik-Goose Bay Road MP 0.0–19.56 improvement project, which included the following independent variables: clearing and grubbing, moose populations, precipitation, snowfall, and maximum snow depth. The results of those analyses are summarized in Table 34. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance *F* is greater than 0.05, and rejected if significance *F* is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 35 shows the results of the analysis with the lowest significance *F*. The analysis with the highest correlation can be determined by looking at the adjusted *r*-squared (used when there is more than one independent variable) or *r*-squared (used when there is only one independent variable) value. The higher the adjusted *r*-squared or *r*-squared, the better the correlation. Set 31 has the highest correlation, with 15.0% of the variation in collisions explained by the independent variables. Since the null hypothesis is accepted, it can be concluded that a relationship between the Number of Reported MVCs and the independent variables does not exist. The resulting linear regression coefficients are provided in Table 36.

Although the null hypothesis is accepted, the relationship between the Number of Reported MVCs, y, and the independent variable and Maximum Snow Depth, x_5 (Clearing and Grubbing, x_1, Moose Population, x_2, Precipitation, x_3, and Snowfall, x_4 were not included in the set), for Set 31 is as follows:

$$\boldsymbol{y} = 6.1680 + (0.1417)\boldsymbol{x}_5$$

Table 34. Summary of Regression Analysis – Knik-Goose Bay Road MP 0.0–19.56

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance F	Adjusted r-squared	r-squared
5	Set 1	■	■	■	■	■	■	0.8414	-0.5255	N/A
4	Set 2	■	■	■	■	■		0.7772	-0.3319	N/A
4	Set 3	■	■	■	■		■	0.6889	-0.2269	N/A
4	Set 4	■	■	■		■	■	0.7658	-0.3178	N/A
4	Set 5	■	■		■	■	■	0.6833	-0.2205	N/A
4	Set 6	■		■	■	■	■	0.7607	-0.3116	N/A
3	Set 7	■	■	■	■			0.6409	-0.1560	N/A
3	Set 8	■	■	■		■		0.6234	-0.1419	N/A
3	Set 9	■	■	■			■	0.5882	-0.1133	N/A
3	Set 10	■	■		■	■		0.6477	-0.1615	N/A
3	Set 11	■	■		■		■	0.4838	-0.0256	N/A
3	Set 12	■	■			■	■	0.6218	-0.1406	N/A
3	Set 13	■		■	■	■		0.6019	-0.1244	N/A
3	Set 14	■		■	■		■	0.5831	-0.1092	N/A
3	Set 15	■		■		■	■	0.5973	-0.1207	N/A
3	Set 16	■			■	■	■	0.6439	-0.1584	N/A
2	Set 17	■	■	■				0.5510	-0.0844	N/A
2	Set 18	■	■		■			0.4502	-0.0236	N/A
2	Set 19	■	■			■		0.5401	-0.0782	N/A
2	Set 20	■	■				■	0.3897	0.0178	N/A
2	Set 21	■		■	■			0.4597	-0.0297	N/A
2	Set 22	■		■		■		0.3887	0.0185	N/A
2	Set 23	■		■			■	0.4164	-0.0010	N/A
2	Set 24	■			■	■		0.5004	-0.0550	N/A
2	Set 25	■			■		■	0.4142	0.0005	N/A
2	Set 26	■				■	■	0.5006	-0.0551	N/A
1	Set 27	■	■					0.4751	N/A	0.0656
1	Set 28	■		■				0.2787	N/A	0.1444
1	Set 29	■			■			0.3151	N/A	0.1256
1	Set 30	■				■		0.2975	N/A	0.1344
1	Set 31	■					■	0.2692	N/A	0.1498

■ Variable included in the regression analysis

#.#### Low statistical significance, significance $F > 0.05$

Table 35. Regression Analyses with Statistical Significance – Knik-Goose Bay Road MP 0.0–19.56

			Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Regression Results		
Number of Variables	Analysis Set Number	Number of Reported Accidents	Clearing and Grubbing	Moose Population - Linear	Precipitation (inches)	Snowfall (inches)	Max Snow Depth (inches)	Significance *F*	Adjusted *r*-squared	*r*-squared
1	Set 31							0.2692	N/A	0.1498
1	Set 28							0.2787	N/A	0.1444
1	Set 30							0.2975	N/A	0.1344
1	Set 29							0.3151	N/A	0.1256
2	Set 22							0.3887	0.0185	N/A
2	Set 20							0.3897	0.0178	N/A

(shaded)	Variable included in the regression analysis
#.####	Low statistical significance, significance $F > 0.05$

Table 36. Set 31 Linear Regression Coefficients – Knik-Goose Bay Road MP 0.0-19.56

	Coefficients
Intercept	6.1680
Max Snow Depth (inches)	0.1417

5.11 Combined Analysis

The results of the individual analyses varied substantially, therefore a comparison table was prepared. Table 37 shows the three most statistically significant data sets from each study project. This comparison shows which variable in each data set had the most influence on the number of reported MVC accidents.

Looking at the projects that had a continuous lighting component, most had a negative coefficient, showing that this component leads to a reduction in reported MVCs. The Parks Highway MP 35–37 project had a continuous lighting component, but this corridor had continuous lighting before the project. Since no change was associated with replacing the lighting system, a zero coefficient resulted.

For the projects that had a clearing and grubbing component, clearing and grubbing had a wide variety of coefficients for each data set, most of which were negative, showing that this component leads to a reduction in reported MVCs. It would be beneficial to analyze a combined set of all project data to determine the significance of clearing and grubbing.

Looking at the project that had only a clearing component, the clearing variable was only included in one of the top three most statistically significant data sets and had a large positive coefficient. This could mean that clearing alone does not influence the number of reported MVCs or that is increases the number of reported MVCs. The data for this project, Parks Highway MP 72–83, were shown to have low statistical significance, possibly because of the low number of data since these project data were available only 2 years past the construction date.

The following are all the variables, from highest influence to lowest, based on inclusion in the data sets: Continuous Lighting (7/15 or 46.7%), Moose Population (12/30 or 30.0%), Maximum Snow Depth (12/30 or 40.0%), Clearing and Grubbing (8/21 or 38.1%), Clearing (1/3 or 33.3%), Snowfall (10/30 or 33.3%), and Precipitation (8/30 or 26.7%).

Table 37. Linear Regression Coefficients Comparison

	Number of Variables	Analysis Set Number	Number of Reported Accidents	Variable 1: Clearing and Grubbing	Variable 2: Continuous Lighting	Variable 3: Clearing	Variable 4: Moose Population - Linear	Variable 5: Precipitation (inches)	Variable 6: Snow Fall (inches)	Variable 7: Max Snow Depth (inches)	Regression Results: Significance *F*	Regression Results: Adjusted *r*-squared	Regression Results: *r*-squared
Sterling Hwy MP 82.0-93.72	1	Set 31	2.7306							0.4290	0.0464	N/A	0.4091
	1	Set 30	3.2838						0.1438		0.0664	N/A	0.3606
	2	Set 19	3.2129	-4.9297					0.1776		0.0970	0.3398	N/A
Kalifornsky Beach Rd MP 16.4-22.4	1	Set 28	-21.6329				0.0313				0.1306	N/A	0.2618
	1	Set 27	9.6000	-4.0000							0.2242	N/A	0.1783
	2	Set 24	-26.6469				0.0332			0.1474	0.2278	0.1575	N/A
Glenn Hwy MP 4 - 11	2	Set 43	30.8	0	-17.2						0.0334	0.2202	N/A
	1	Set 58	30.8	-17.2							0.0434	N/A	0.4179
	1	Set 59	30.8		-17.2						0.0434	N/A	0.4179
Glenn Hwy MP 3.24 – 11.46	2	Set 19	24.3006		5.9046				-0.1753		0.0312	0.5226	N/A
	3	Set 10	17.9577		5.3296			0.6810	-0.2345		0.0446	0.5733	N/A
	2	Set 20	19.6524		5.2696					-0.3478	0.0598	0.4250	N/A
Glenn Hwy MP 30.7-33.5	3	Set 31	1.3096	-3.8894				0.4548		-0.1624	0.0018	0.8585	N/A
	3	Set 37	1.3096		-3.8894			0.4548		-0.1624	0.0018	0.8585	N/A
	4	Set 12	1.3096	0.0000	-3.8894			0.4548		-0.1624	0.0031	0.6919	N/A
Glenn Hwy MP 12.082-16.5	1	Set 28	-14.8503				0.0109				0.0047	N/A	0.6524
	2	Set 21	-11.8687				0.0118	-0.2452			0.0095	0.6599	N/A
	3	Set 14	-12.4725				0.0125	-0.4699		0.1501	0.0126	0.7245	N/A
Parks Hwy MP 35-37	3	Set 41	-3.4721				0.0004		0.0457	-0.0768	0.0053	0.7949	N/A
	4	Set 16	-5.7369	-0.6753			0.0009		0.0503	-0.0921	0.0066	0.8496	N/A
	2	Set 57	-1.1198						0.0438	-0.0652	0.0074	0.6834	N/A
Parks Hwy MP 37-39	2	Set 22	9.0601				-0.0015		0.0281		0.2191	0.1668	N/A
	1	Set 28	9.4385				-0.0012				0.2548	N/A	0.1583
	1	Set 27	2.2	-0.8							0.4236	N/A	0.1187
Parks Hwy MP 72-83	2	Set 25	12.8091					-1.3763		0.6640	0.1833	0.3577	N/A
	1	Set 28	14.8405				-0.0058				0.2067	N/A	0.2961
	4	Set 2	108.7656			41.7785	-0.0328	-2.3136	-0.1663		0.2494	0.5991	N/A
Knik-Goose Bay Rd MP 0.0-19.56	1	Set 31	6.1680							0.1417	0.2692	N/A	0.1498
	1	Set 28	-12.3412				0.0033				0.2787	N/A	0.1444
	1	Set 30	5.1231						0.0508		0.2975	N/A	0.1344
				38.1%	46.7%	33.3%	40.0%	26.7%	33.3%	40.0%			

Variable included in the regression analysis (Clearing and Grubbing project)
Variable included in the regression analysis (Clearing and Grubbing and/or Continuous Lighting project)
Variable included in the regression analysis (Clearing project)
Variable not included in the regression analysis
#.#### Low statistical significance, significance $F > 0.05$

All project corridors were included in a combined data set, which included the following independent variables: clearing and grubbing, continuous lighting, clearing, moose populations, precipitation, snowfall, and maximum snow depth. In total, 127 different analyses are possible based on the number of variable combinations. From the information in Table 37 and the results shown in Table 38 through Table 42 the data set can be adjusted by looking at the *p*-values for each variable. In Table 38, Clearing and Grubbing has the highest *p*-value of 0.5563. This is the *p*-value of the hypothesis test H_0: $\beta_1 = 0$. To reject it is to conclude that there is a significant relationship between *x* and *y*. A *p*-value over 0.05 shows low statistical significance and can, therefore, be rejected or removed from the data set. The variable with the highest *p*-value was removed and the set was re-analyzed until all remaining variables had a resulting *p*-value less than 0.05.

Table 38. Combined Linear Regression Coefficients and *p*-values – Full Set

	Coefficients	*P-value*
Intercept	11.7358	0.0205
Clearing and Grubbing	1.0496	0.5563
Continuous Lighting	-5.3104	0.0086
Clearing	-8.6803	0.1620
Moose Population - Linear	-0.0009	0.0240
Precipitation (inches)	0.1950	0.4847
Snowfall (inches)	-0.0572	0.2007
Max Snow Depth (inches)	0.0976	0.4190

The results of the analyses are shown in Table 38 through Table 42. To test the null hypothesis:

H_0: The number of reported MVCs is independent of the independent variables.

H_0 is accepted if significance *F* is greater than 0.05, and rejected if significance *F* is less than 0.05. If the null hypothesis is rejected, it can be assumed that there is a significant relationship between the number of reported MVCs and the independent variables. Table 42 shows the results of the final analysis where each variable *p*-value was less than 0.05. This data set resulted in a significance *F* of 0.0009. Since multiple variables were included in the analysis, the relationship can be determined by looking at the adjusted *r*-squared (used when there is more than one independent variable) value. The higher the adjusted *r*-squared, the better the correlation. For the combined set, 12.0% of the variation in collisions is explained by the independent variables. The resulting linear regression coefficients are provided in

Table 42. Therefore, the relationship between the Number of Reported MVCs, y, and the independent variables, Continuous Lighting, x_2, and Moose Population, x_4, (Clearing and Grubbing, x_1, Clearing, x_3, Precipitation, x_5 Snowfall, x_6, Maximum Snow Depth, x_7, were not included in the set), is as follows:

$$\boldsymbol{y} = 12.9940 + (-4.9172)\boldsymbol{x_2} + (-0.0009)\boldsymbol{x_4}$$

An adjusted r-squared value of 12.0% is low and likely means that there are more contributing factors in MVCs.

Table 39. Combined Linear Regression Coefficients and *p*-values-without Clearing and Grubbing

	Coefficients	*P-value*
Intercept	11.5884	0.0215
Continuous Lighting	-5.1043	0.0099
Clearing	-9.1354	0.1368
Moose Population - Linear	-0.0009	0.0279
Precipitation (inches)	0.2189	0.4262
Snowfall (inches)	-0.0570	0.2006
Max Snow Depth (inches)	0.0954	0.4279

Table 40. Combined Linear Regression Coefficients and *p*-values-without Clearing and Grubbing and Max Snow Depth

	Coefficients	*P-value*
Intercept	11.7867	0.0190
Continuous Lighting	-5.1596	0.0090
Clearing	-9.1298	0.1362
Moose Population - Linear	-0.0009	0.0266
Precipitation (inches)	0.2545	0.3478
Snowfall (inches)	-0.0395	0.3047

Table 41. Combined Linear Regression Coefficients and P-values-without Clearing and Grubbing, Max Snow Depth, and Precipitation

	Coefficients	*P-value*
Intercept	15.3723	0.0000
Continuous Lighting	-5.0507	0.0103
Clearing	-8.2074	0.1740
Moose Population - Linear	-0.0010	0.0152
Snowfall (inches)	-0.0259	0.4664

Table 42. Combined Linear Regression Coefficients and P-values-without Clearing and Grubbing, Max Snow Depth, Precipitation, and Snowfall

	Coefficients	*P-value*
Intercept	13.4184	0.0000
Continuous Lighting	-5.1242	0.0090
Clearing	-9.2104	0.1167
Moose Population - Linear	-0.0010	0.0146

Chapter 6 Discussion of Findings

Each corridor evaluated resulted in various levels of statistical significance with the various variables included, possibly due to small corridor segments (the shortest corridors were 2 miles long) and to limited data. According to the 2009 Alaska Traffic Crashes report, Law enforcement agencies may not perform a formal crash investigation when there are no apparent injuries, when the crash does not involve collision with wildlife, and when all vehicles can be driven away from the crash scene. If police decline to investigate, some drivers may not understand their obligation to report a collision, or may choose not to report the crash to the Division of Motor Vehicles (DOT&PF, 2012). The data used in the study only capture reported crashes. It is very likely that MVCs are often not reported when the impact does not injure the moose or if the moose wanders away from the collision. In order to determine if there is an overall trend, a combined analysis was run.

The results of the regression analyses are summarized in Table 43. Four project results were inconclusive; thus, a relationship between the number of reported MVCs and the independent variables was not determined to be statistically significant. The results from the other projects show between 22.0% and 85.9% of the variation in crashes being explained by the independent variables, with differing results on which variables contributed to the number of MVCs. There was also variation among the projects in whether a variable contributed to an increase or decrease in the number of MVCs (i.e., moose population contributed to a decrease in MVCs for Parks Highway MP 37–39 and an increase in MVCs for Kalifornsky Beach Road MP 16.4–22.4). These results show that the variables do not capture all the contributing factors related to MVCs. For the combined set, regression analysis resulted in only 12.0% of the variation in crashes being explained by the independent variables. This result also shows that more contributing factors affect MVCs than were included in this study.

Projects in this study with clearing and grubbing as a mitigation measure showed variation in trends post construction with some dipping, rising then falling and others steadily rising. This increase may be linked to regrowth of vegetation surrounding the project corridor. The decrease in some corridors after a rise may indicate that DOT&PF Maintenance and Operations performed clearing of re-vegetated areas or older growth is less of an attractant for moose.

The five-year average number of reported accidents by project corridor is summarized in Table 44. Most of the clearing and grubbing projects resulted in the five-year average decreasing post project completion, with only the Knik-Goose Bay Road corridor showing an increase. This corridor showed a spike in MVCs five years post construction completion, possibly due to vegetation regrowth attracting moose for grazing or obstructing the driver's view of the moose. The projects with only continuous lighting as a corridor improvement varied, one indicated that the improvement increased the number of MVCs and the other showed a drop in MVCs. This increase could be attributed to higher driving speeds on the newly lighted roadway, and increase in moose population, or other factors not included in this study. The projects that included both corridor improvements showed a significant decrease in the five-year average post construction, except Parks Highway MP 35–37 which showed an increase. This corridor was only two miles long and most years in the study did not have any reported MVCs. The results for the other two corridors with the combination of improvements indicated that the mitigation measures were successful in reducing MVCs on those corridors.

Table 43. Regression Analysis Summary

Corridor improvement	Project	Percentage of the variation in crashes being explained by the independent variables	Variables included	Contribution to the number of MVCs
Clearing and Grubbing	Sterling Highway MP 82.0–93.72	40.9%	• Maximum Snow Depth, x_5	Increase
	Kalifornsky Beach Road MP 16.4–22.4	26.2% (No Correlation)	• Moose Population, x_2	Increase
	Parks Highway MP 37–39	16.7% (No Correlation)	• Moose Population, x_2 • Snowfall, x_4,	Decrease Increase
	Knik-Goose Bay Road MP 0.0–19.56	15.0% (No Correlation)	• Maximum Snow Depth, x_5	Increase
Clearing and Grubbing and Continuous Lighting	Glenn Highway MP 4–11	22.0%	• Clearing and Grubbing, x_1 or Continuous Lighting, x_2	Decrease
	Glenn Highway MP 30.7–33.5	85.9%	• Clearing and Grubbing, x_1 or Continuous Lighting, x_2 • Precipitation, x_4 • Maximum Snow Depth, x_6	Decrease Increase Decrease
	Parks Highway MP 35–37	79.5%	• Moose Population, x_3, • Snowfall, x_5, • Maximum Snow Depth, x_6	Increase Increase Decrease
Continuous Lighting	Glenn Highway MP 3.24–11.46	52.3%	• Continuous Lighting, x_1 • Snowfall, x_4	Increase Decrease
	Glenn Highway MP 12.082–16.5	65.2%	• Moose Population, x_2	Increase
Clearing	Parks Highway MP 72–83	35.8% (No Correlation)	• Precipitation, x_3 • Maximum Snow Depth, x_5	Decrease Increase
Combined	All Project Corridors	12.0%	• Continuous Lighting, x_2 • Moose Population, x_4	Decrease Decrease

Table 44. Five-Year Average Number of Reported Accidents by Project Corridor

Corridor Improvement	Project	Five-Year Average Prior to Project Completion (MVCs/year)	Five-Year Average Post Project Completion (MVCs/year)	Percent Change
Clearing and Grubbing	Sterling Highway MP 82.0–93.72	14.8	13.4	9.5% decrease
	Kalifornsky Beach Road MP 16.4–22.4	9.6	5.6	41.7% decrease
	Parks Highway MP 37–39	2.2	1.4	36.4% decrease
	Knik-Goose Bay Road MP 0.0–19.56	8.4	10.0	19.0% increase
Clearing and Grubbing and Continuous Lighting	Glenn Highway MP 4–11	30.8	13.6	55.8% decrease
	Glenn Highway MP 30.7–33.5	4.6	2.4	47.8% decrease
	Parks Highway MP 35–37	0.4	0.8	100% increase
Continuous Lighting	Glenn Highway MP 3.24–11.46	12.0	17.2	43.3% increase
	Glenn Highway MP 12.082–16.5	5.6	2.8	50.0% decrease
Clearing	Parks Highway MP 72–83	5.2	2.0 *	61.5% decrease

* Value is a two-year average.

Chapter 7 Conclusions

In previous studies, MVCs were found to be a product of several environmental factors: landscape, road and traffic characteristics, moose migration and behavior, moose density, vehicle speed, traffic volume, visibility in relation to lighting, and the amount of and proximity to preferred habitat. The factors considered in this study included clearing and grubbing and/or lighting (visibility, landscape, and moose grazing components), moose population (moose density), and weather (affects road and traffic characteristics). The results suggest that several factors not considered are likely needed to achieve the required significance in data to accurately predict the number of MVCs, given construction improvements and the environmental factors present in a corridor. Further studies involving vehicle speed and traffic volume are recommended.

Reported effective mitigation measures identified in previous studies are fencing, wildlife passages, reduced driving speeds at night, moose population control, and roadside illumination. This study included illumination, although the results were inconclusive. Of the effective mitigation measures identified, fencing is a more common method used in Alaska. Therefore, it is recommended that corridors with fencing improvements also be analyzed to determine the significance of fencing in reducing the number of MVCs.

This study showed that there is a consistent drop in the number of moose-vehicle collisions following clearing and grubbing, with the exception of one corridor. Similar to the clearing and grubbing projects, the clearing and grubbing and continuous lighting projects showed a consistent trend of a drop in the number of moose-vehicle collisions following project completion. The projects with clearing and grubbing as a component had varying MVCs trends post construction, which may indicate that DOT&PF Maintenance and Operations performed clearing of re-vegetated areas or older growth is less of an attractant for moose. Tracking Maintenance and Operations activities and regrowth post construction could continue to improve data for future re-evaluation. The continuous lighting results were inconclusive with one indicating the mitigation measure lead to an increase in the number of MVCs and the other indicating a reduction.

Although this study resulted in low statistical significance, there is evidence of positive results for the mitigation measures, continuous lighting and clearing and grubbing. Continued monitoring of post construction conditions, Maintenance and Operations events, non-linear regression analysis, and data collection for continued improvements will increase the accuracy of the data for future re-analysis and the development of crash modification factors.

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Appendix A

Data Collection and Characteristics Figures

Appendix A.1. Sterling Highway Milepost (MP) 82.0–93.72

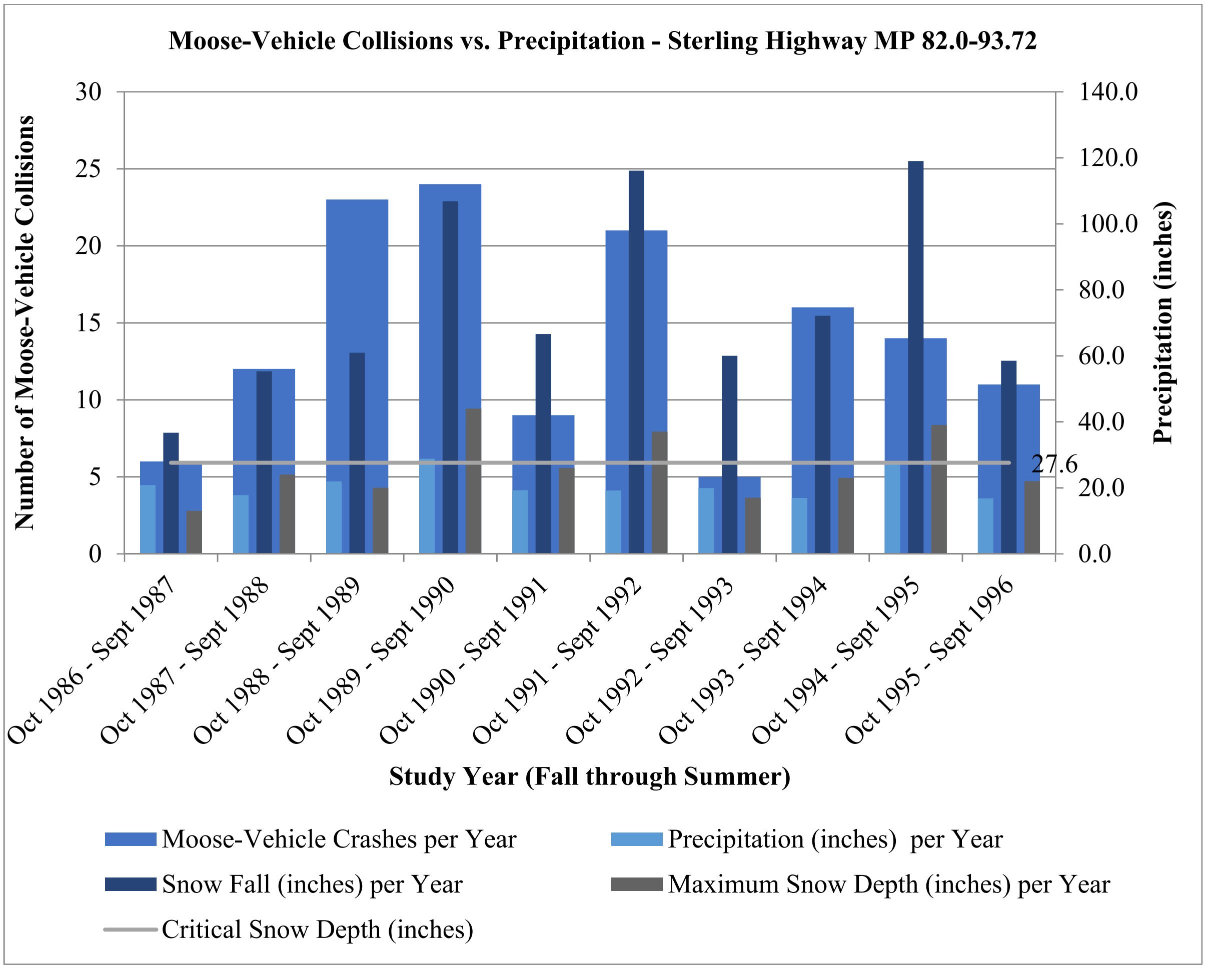

Figure A.1. Moose-Vehicle Collisions vs. Precipitation

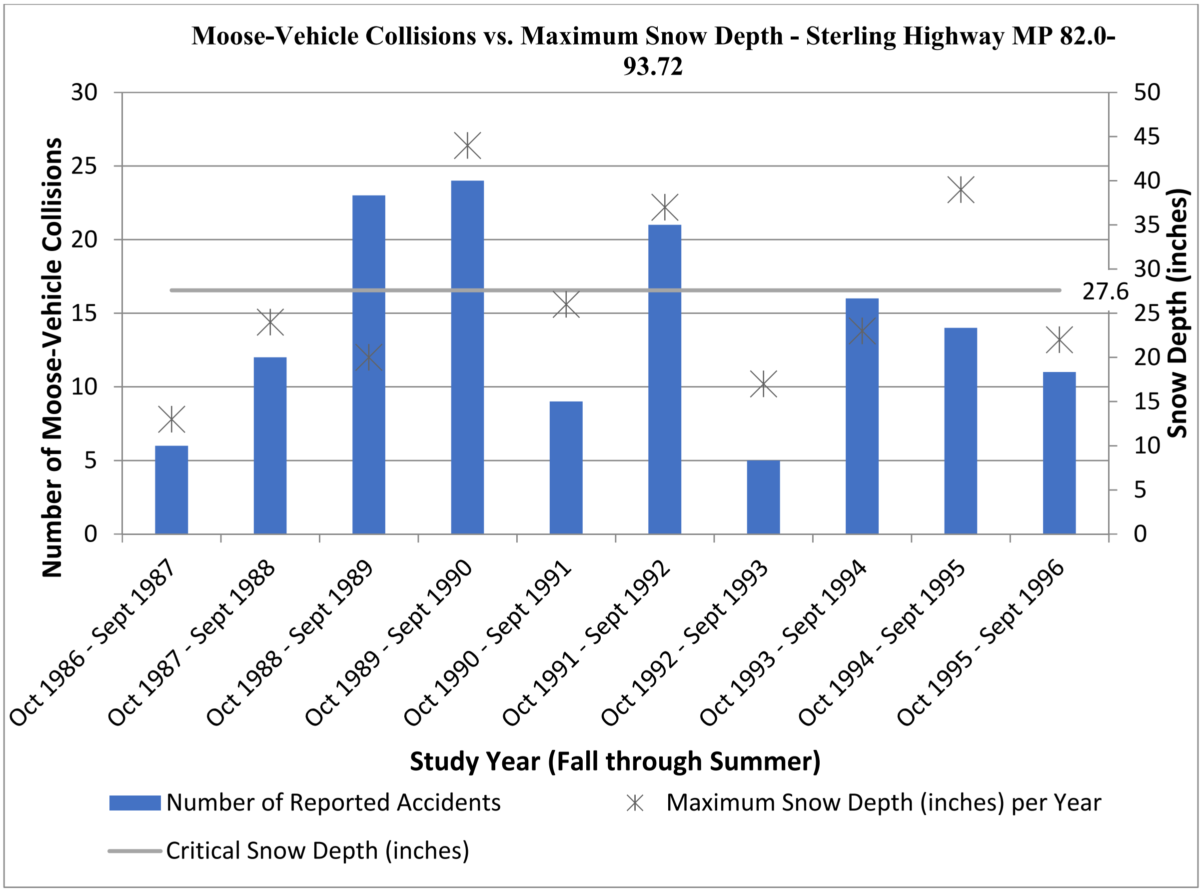

Figure A.2. Moose-Vehicle Collisions vs. Maximum Snow Depth

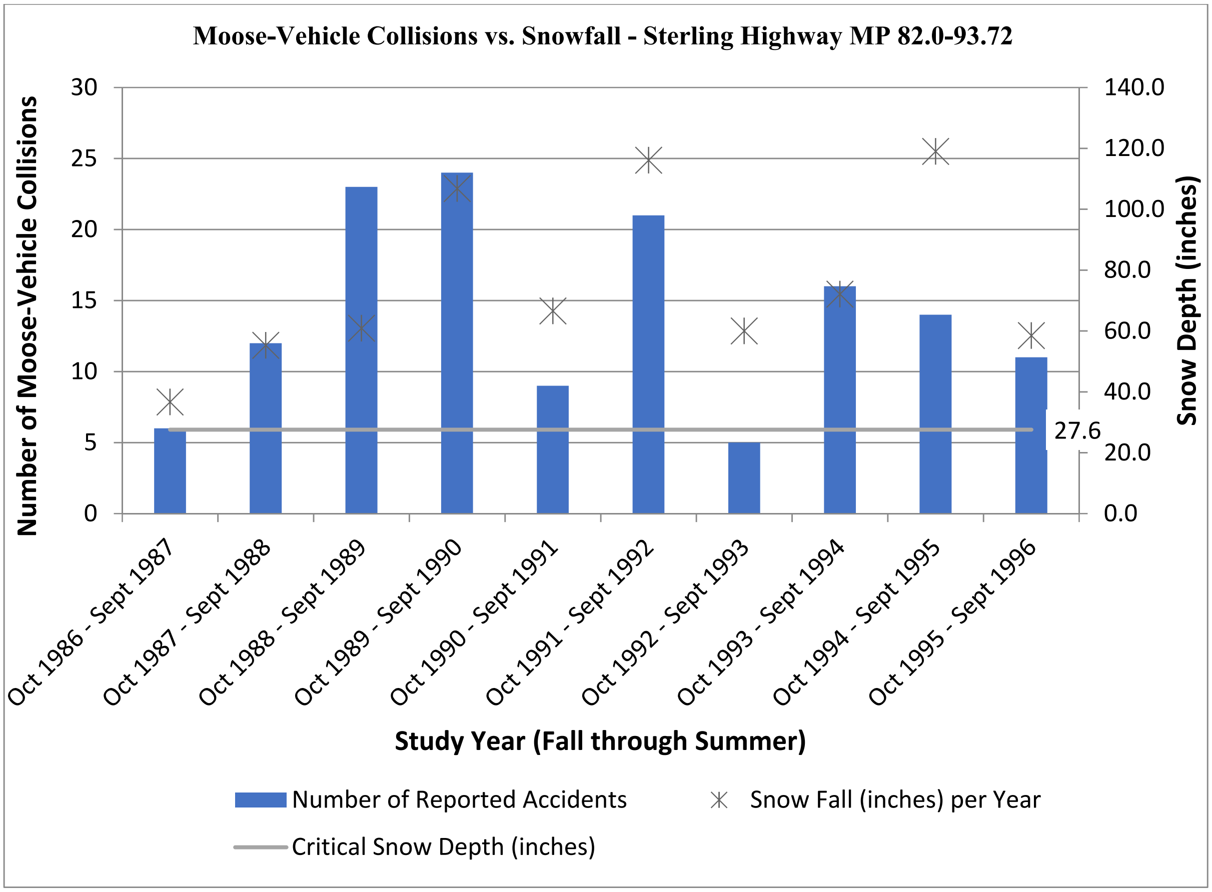

Figure A.3. Moose-Vehicle Collisions vs. Snowfall

Appendix A.2. Kalifornsky Beach Road MP 16.4–22.4

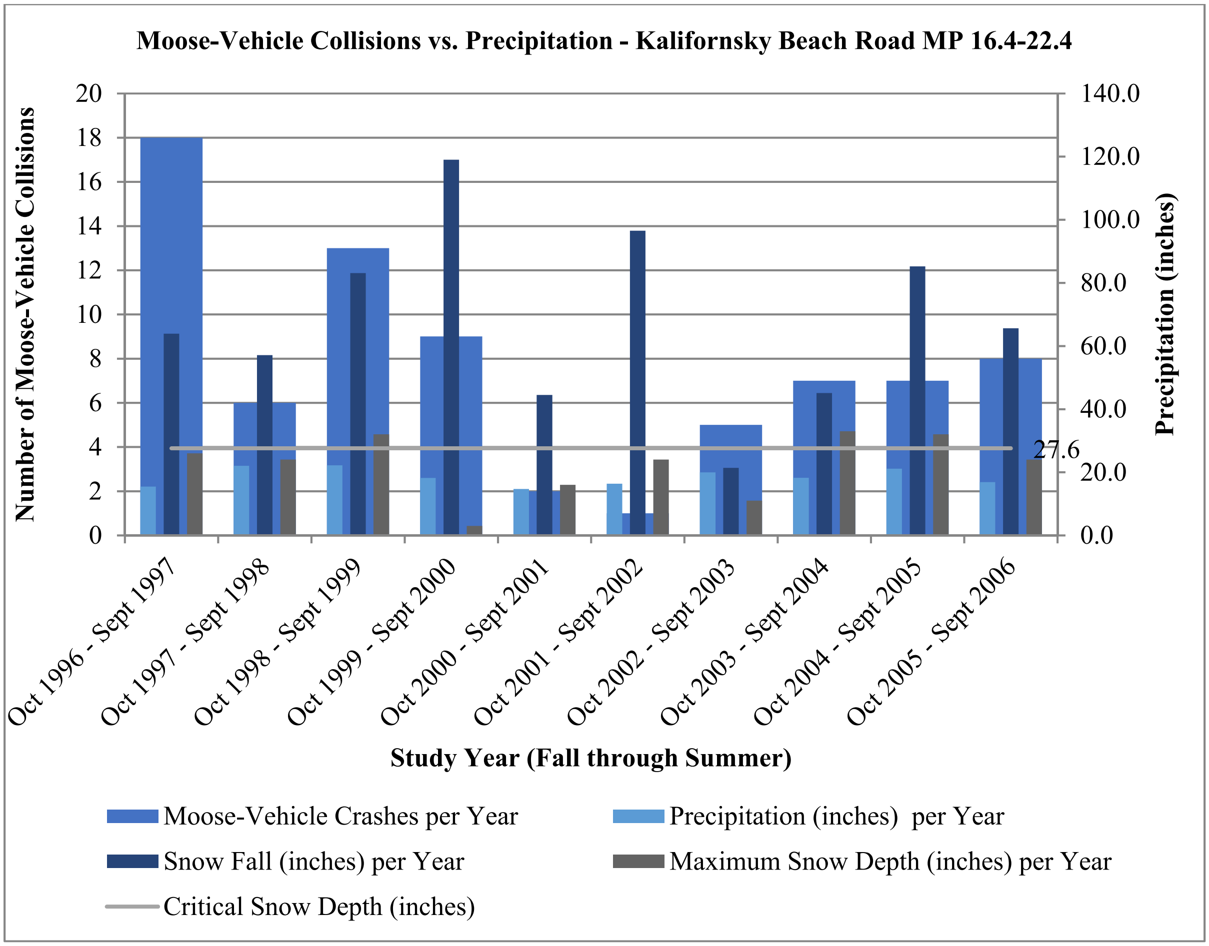

Figure A.4. Moose-Vehicle Collisions vs. Precipitation

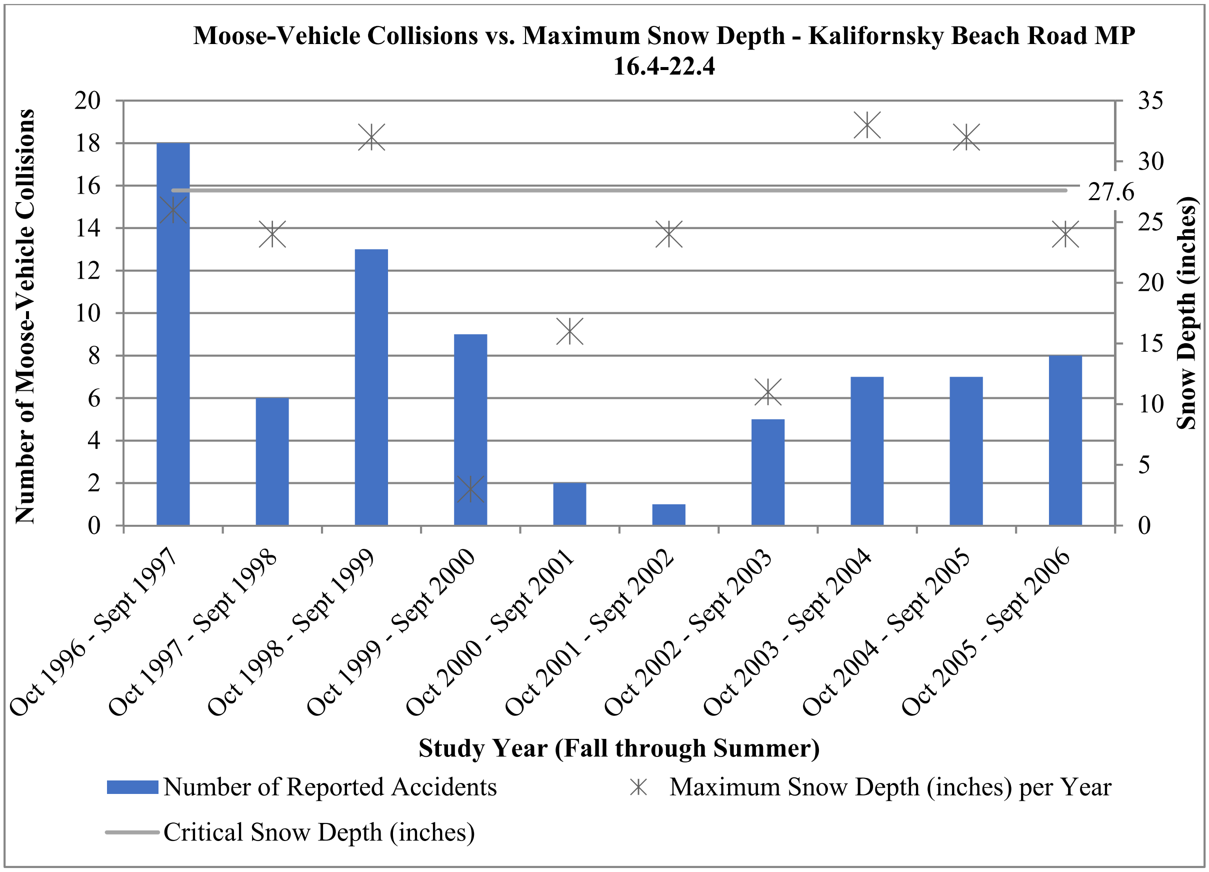

Figure A.5. Moose-Vehicle Collisions vs. Maximum Snow Depth

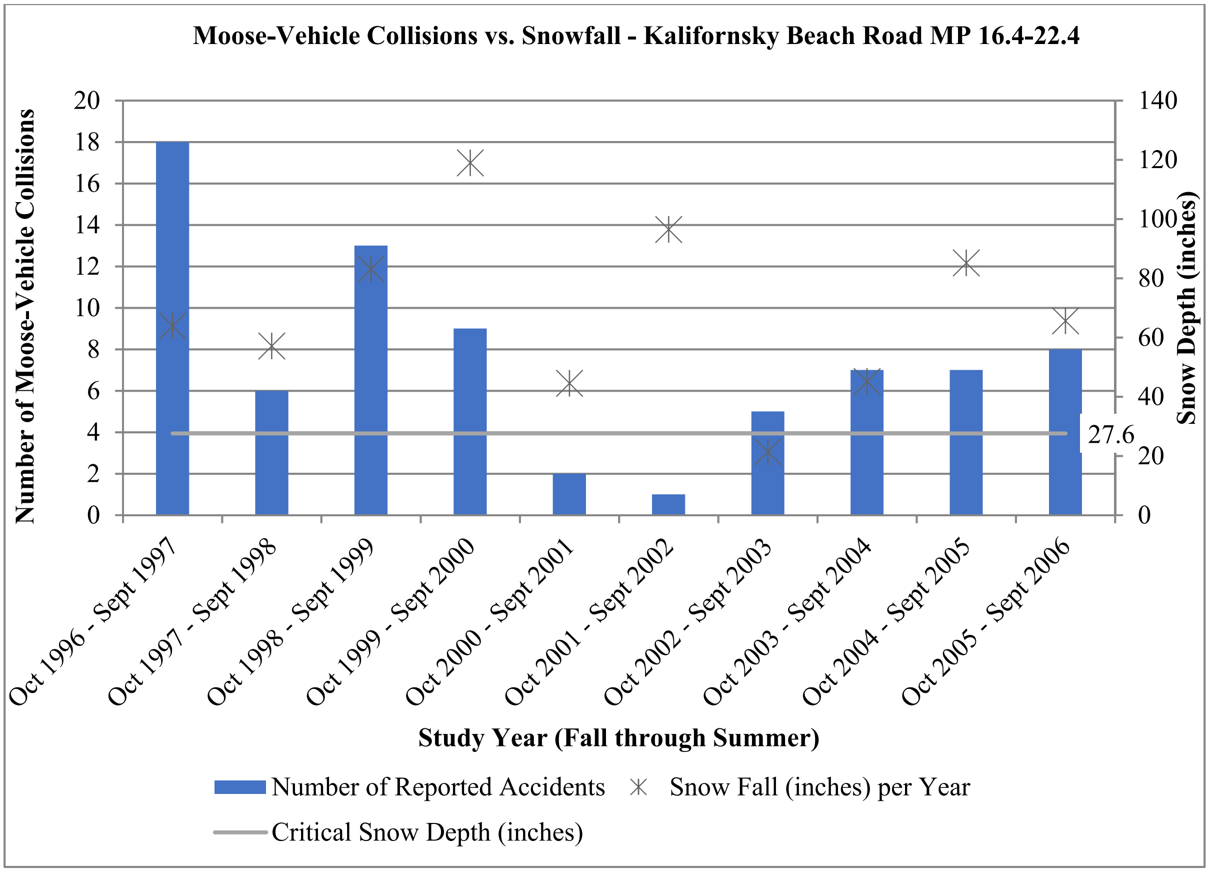

Figure A.6. Moose-Vehicle Collisions vs. Snowfall

Appendix A.3. Glenn Highway MP 4–11

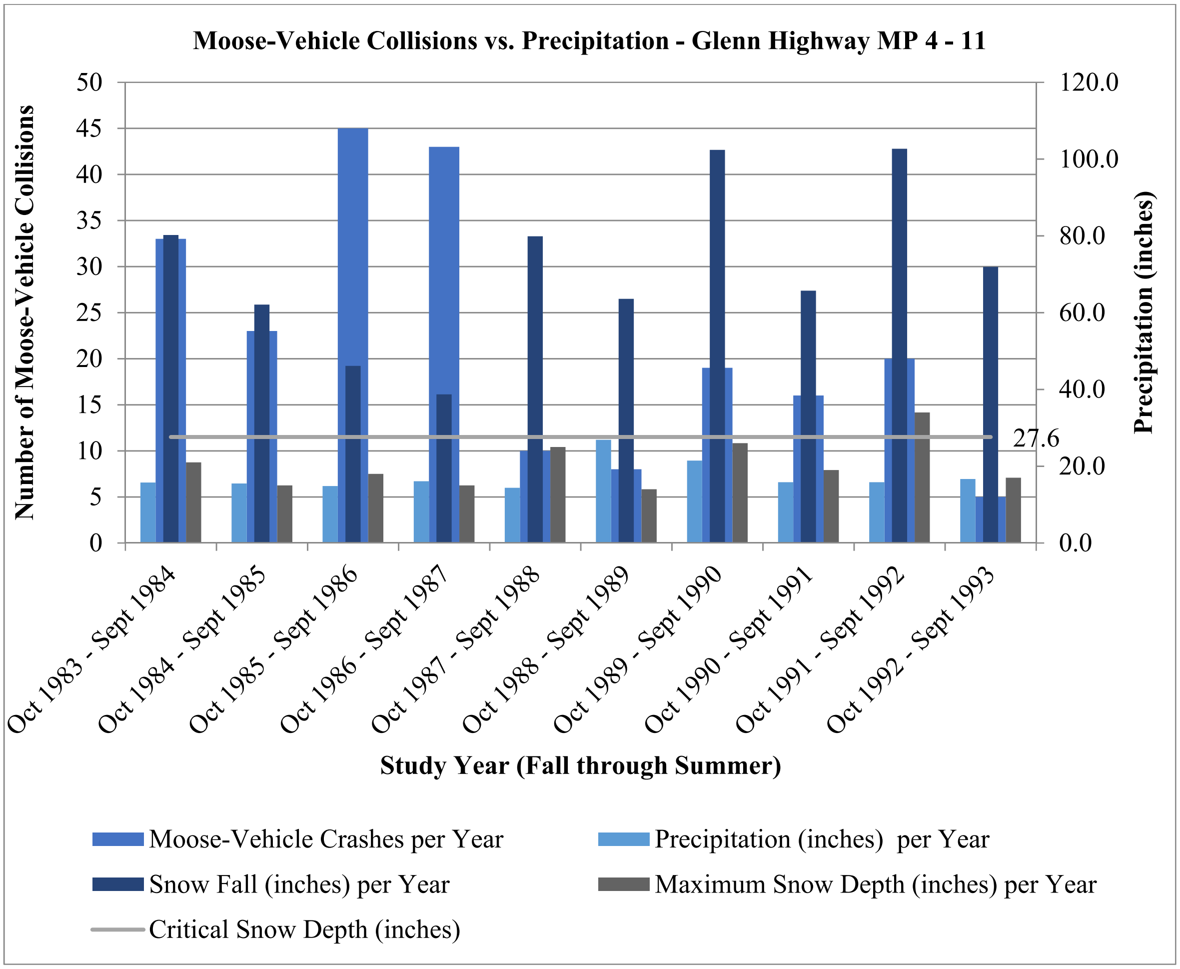

Figure A.7. Moose-Vehicle Collisions vs. Precipitation

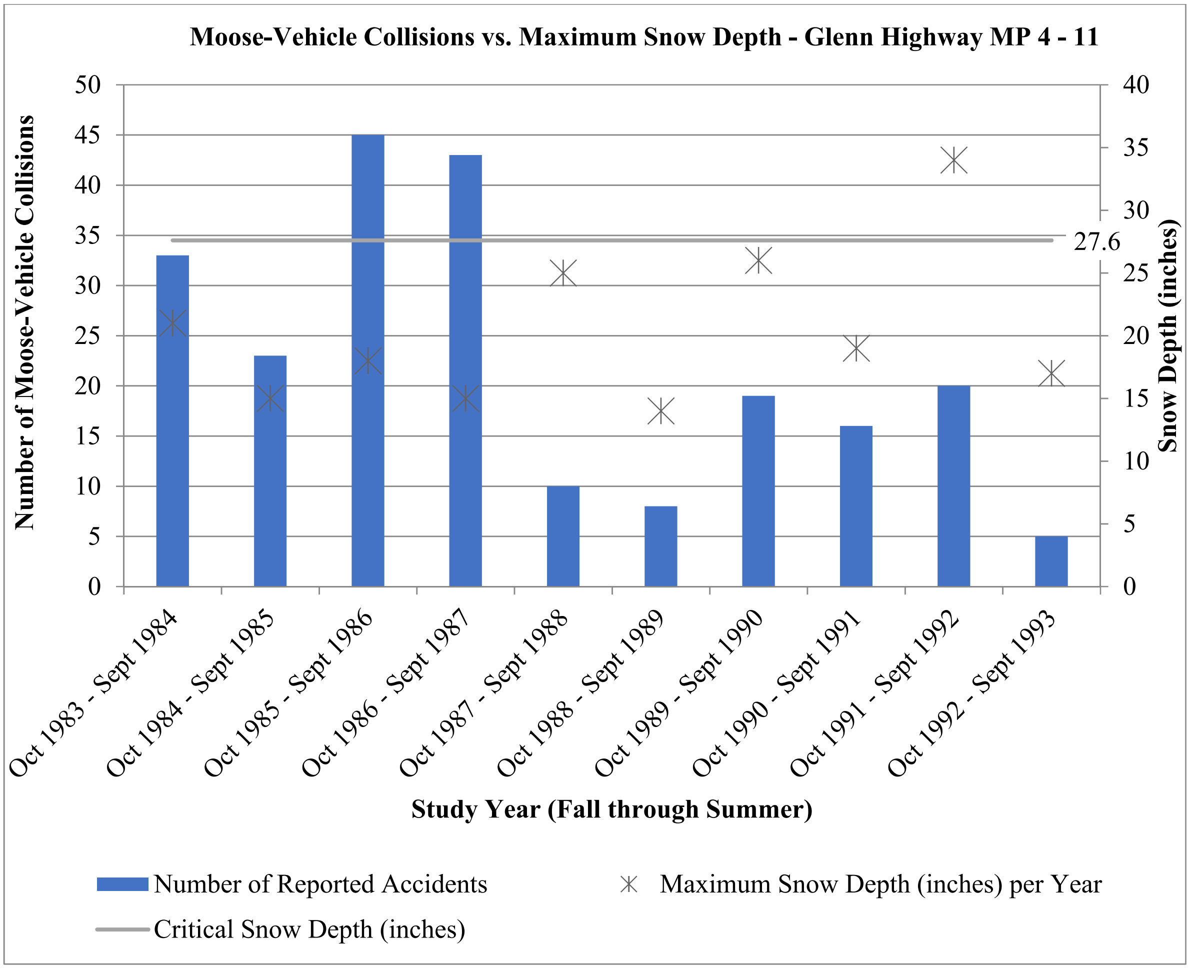

Figure A.8. Moose-Vehicle Collisions vs. Maximum Snow Depth

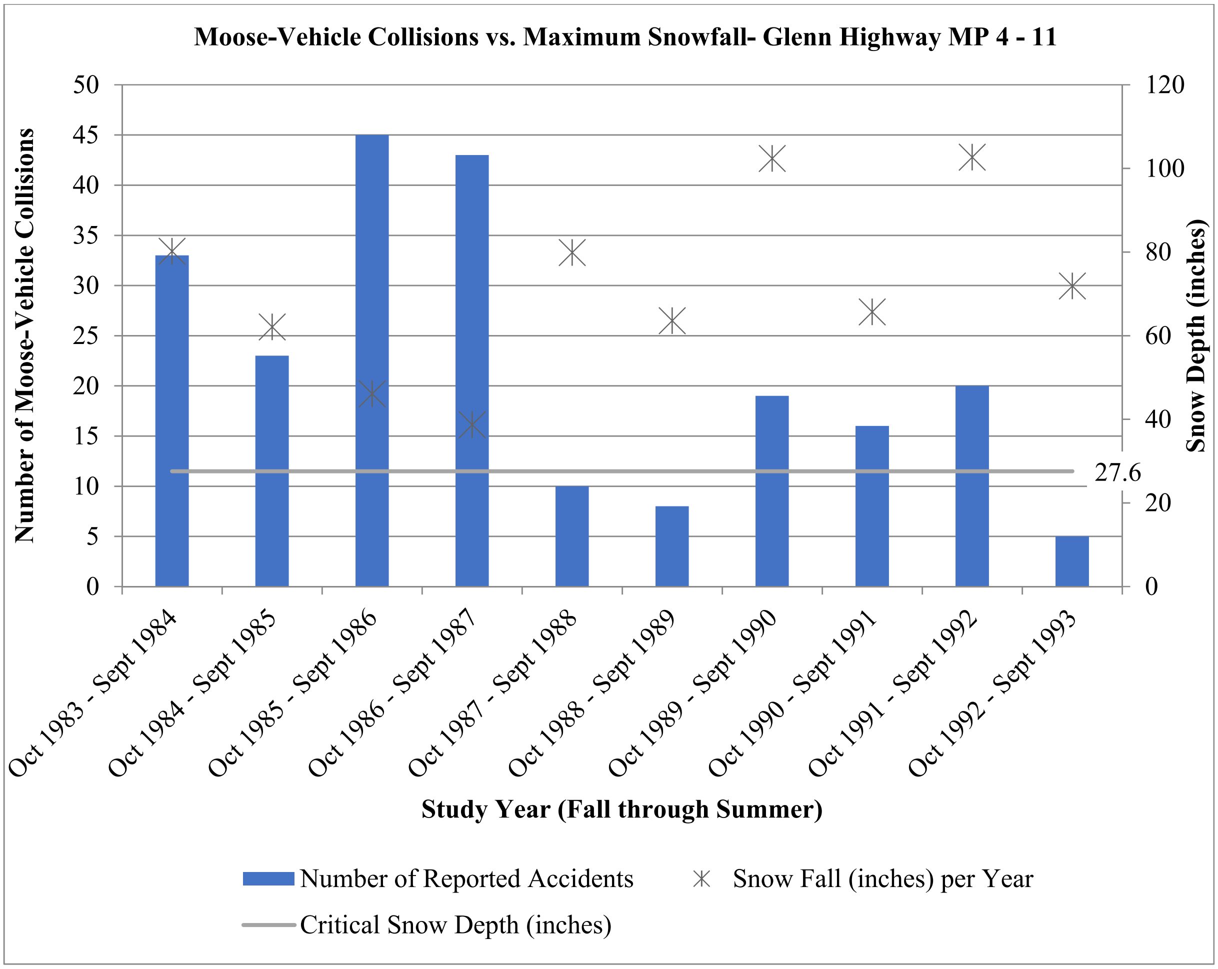

Figure A.9. Moose-Vehicle Collisions vs. Snowfall

Appendix A.4. Glenn Highway MP 3.24–11.46

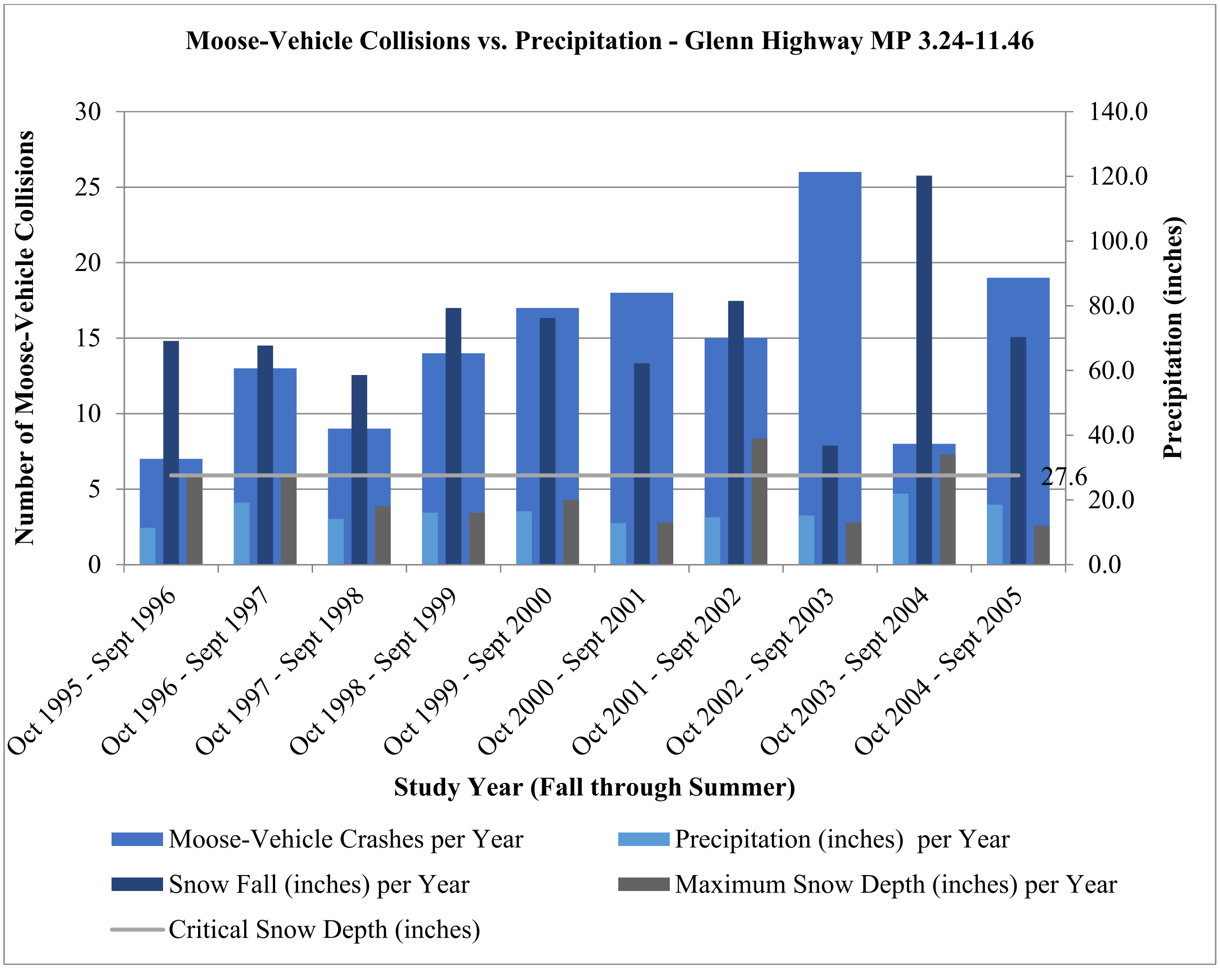

Figure A.10. Moose-Vehicle Collisions vs. Precipitation

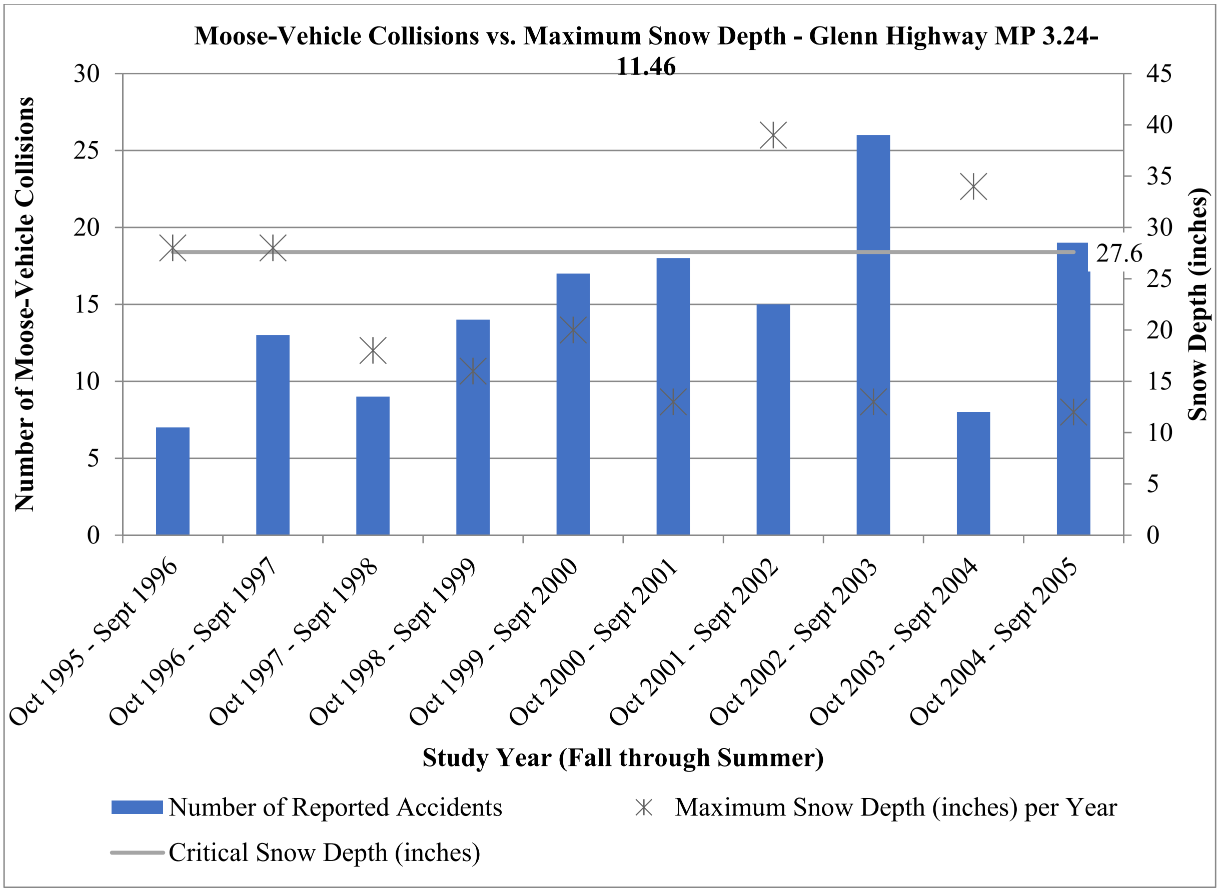

Figure A.11. Moose-Vehicle Collisions vs. Maximum Snow Depth

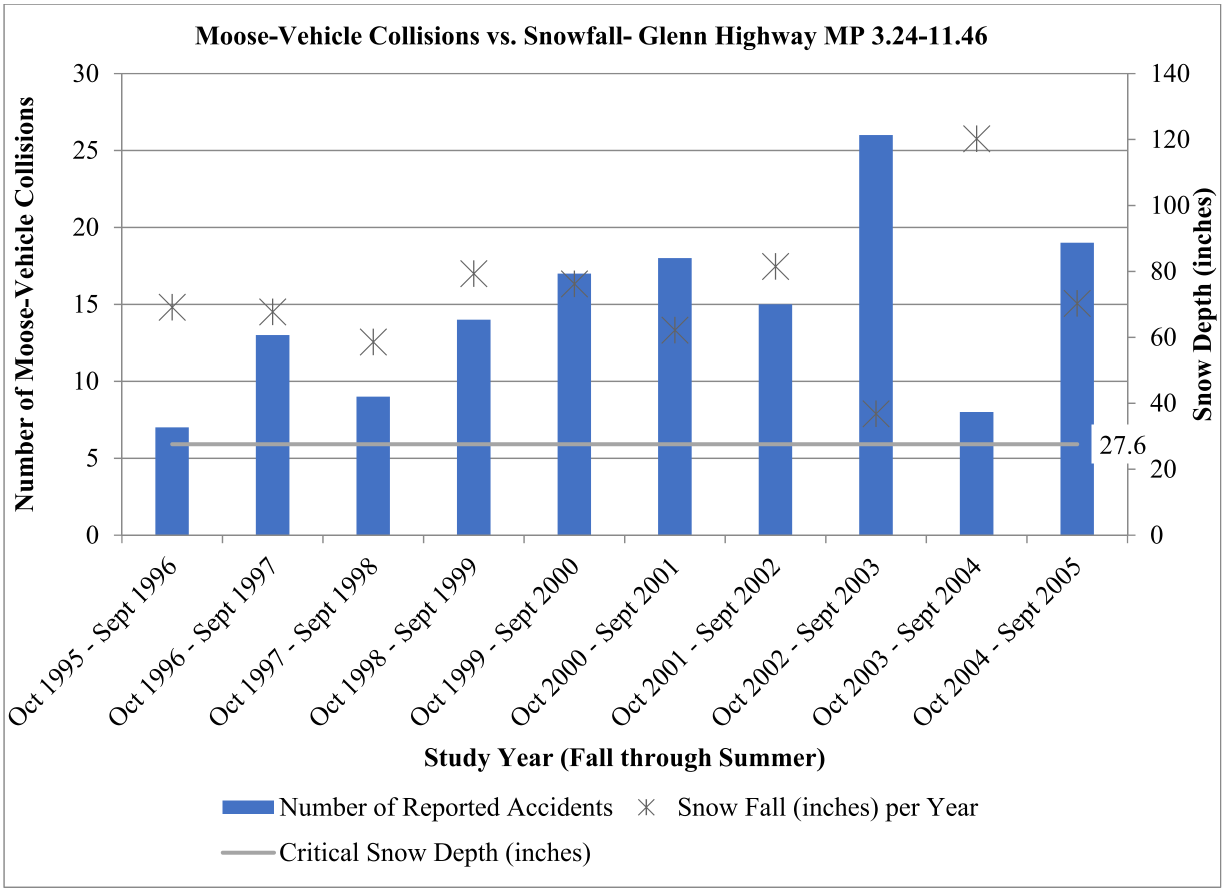

Figure A.12. Moose-Vehicle Collisions vs. Snowfall

Appendix A.5. Glenn Highway MP 30.7–33.5

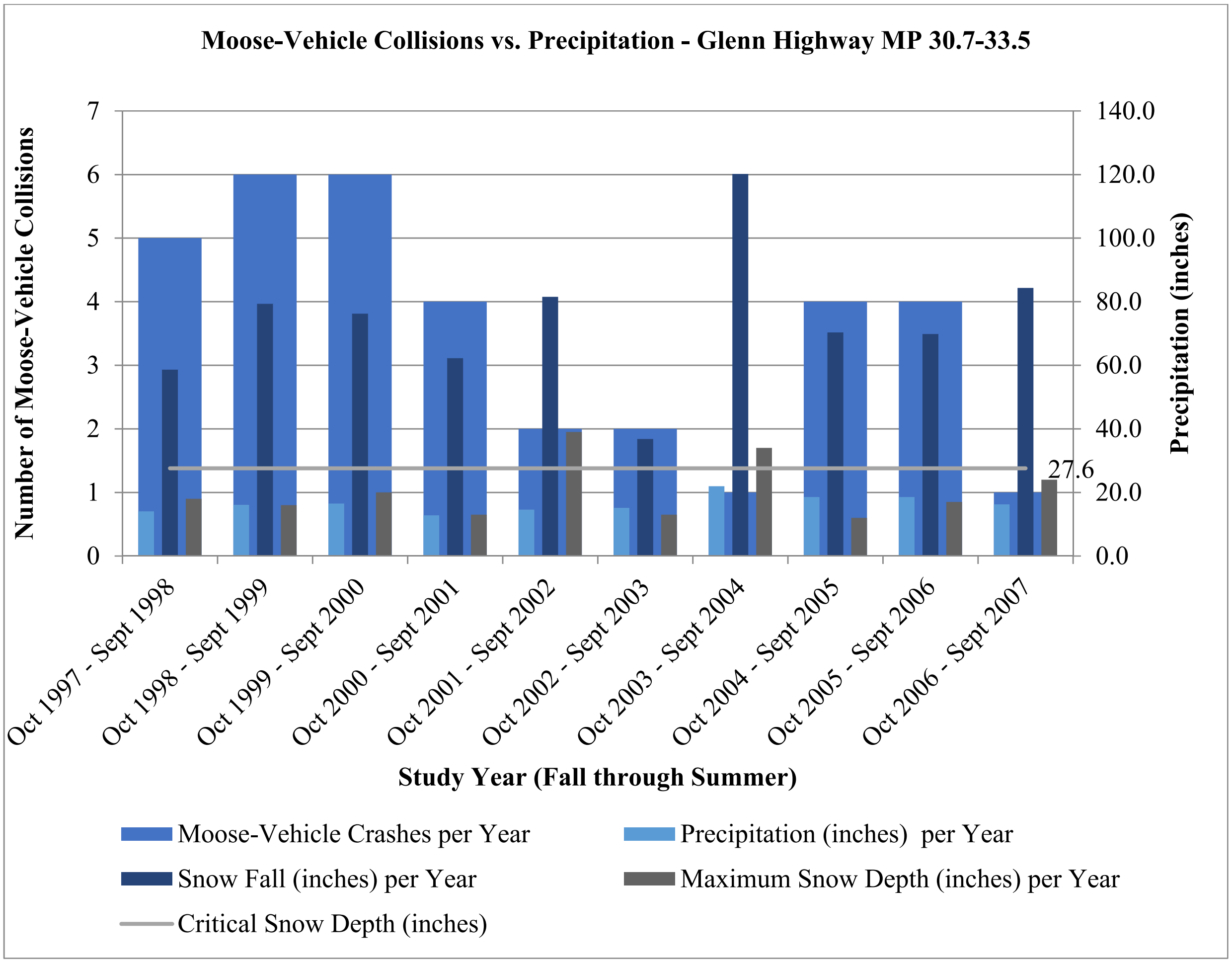

Figure A.13. Moose-Vehicle Collisions vs. Precipitation

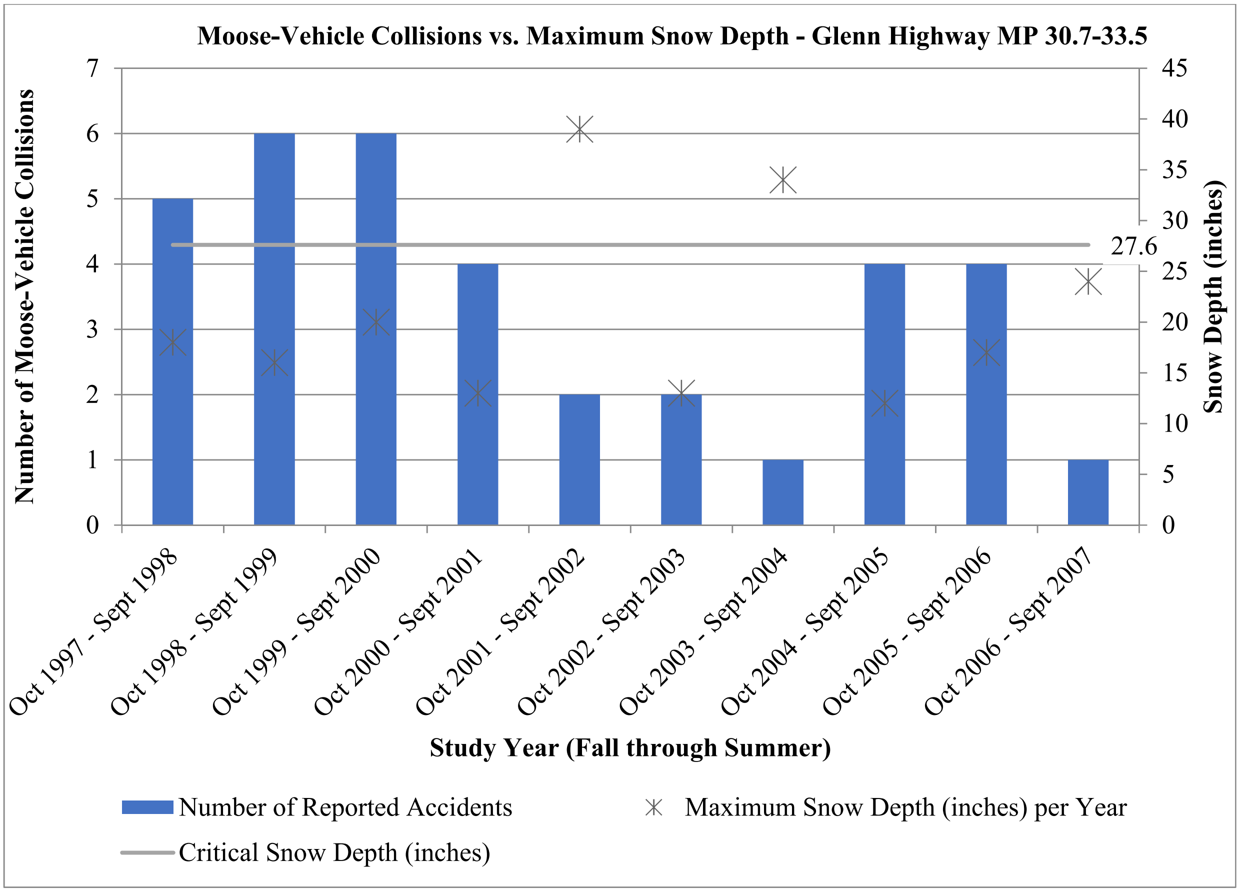

Figure A.14. Moose-Vehicle Collisions vs. Maximum Snow Depth

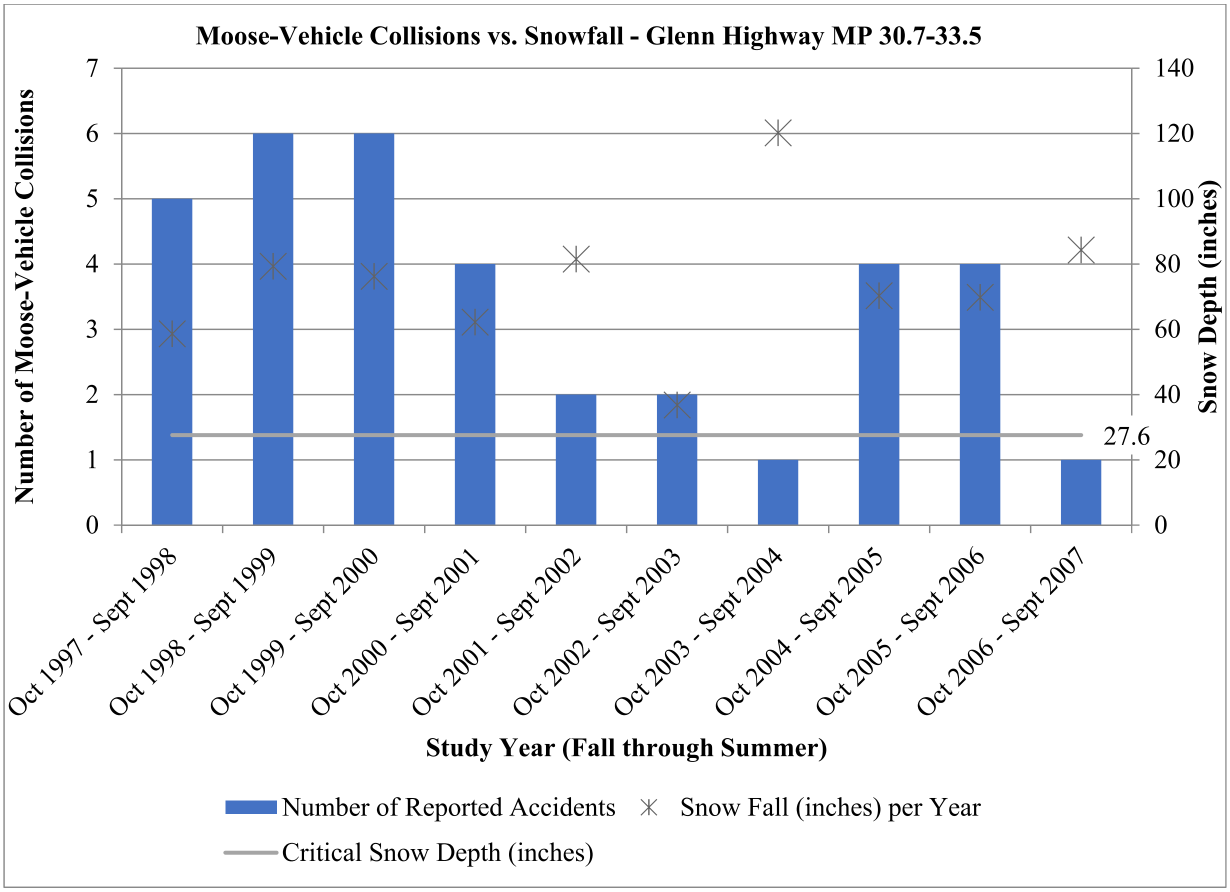

Figure A.15. Moose-Vehicle Collisions vs. Snowfall

Appendix A.6. Glenn Highway MP 12.082–16.5

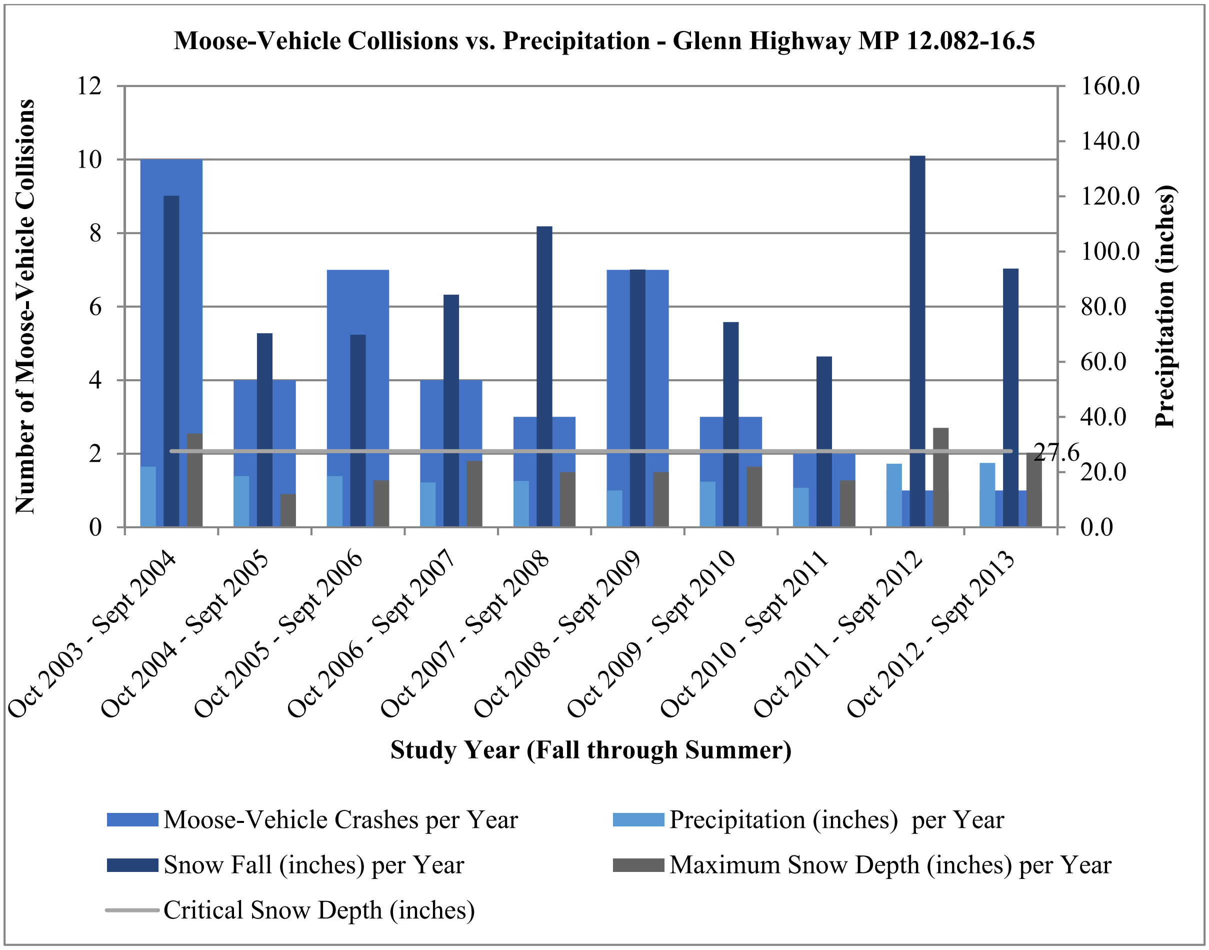

Figure A.16. Moose-Vehicle Collisions vs. Precipitation

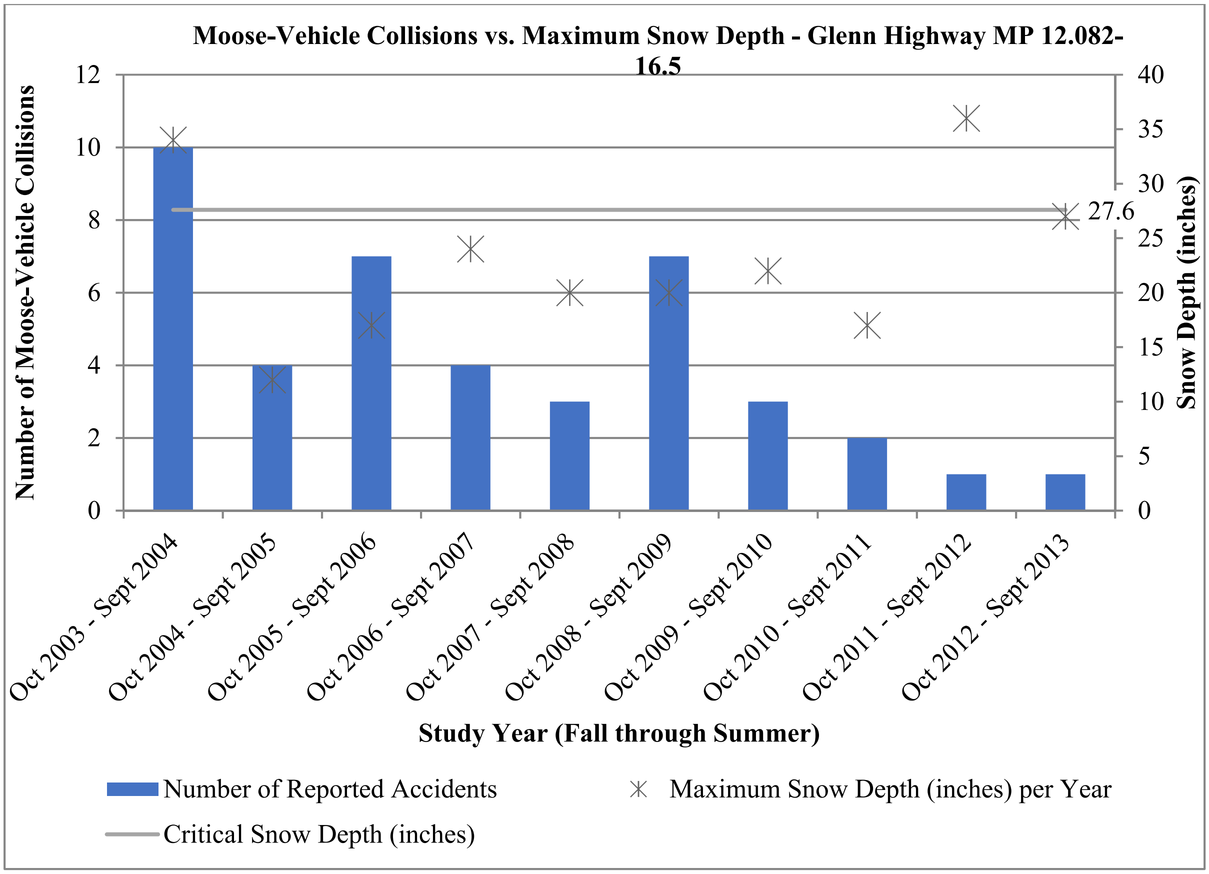

Figure A.17. Moose-Vehicle Collisions vs. Maximum Snow Depth

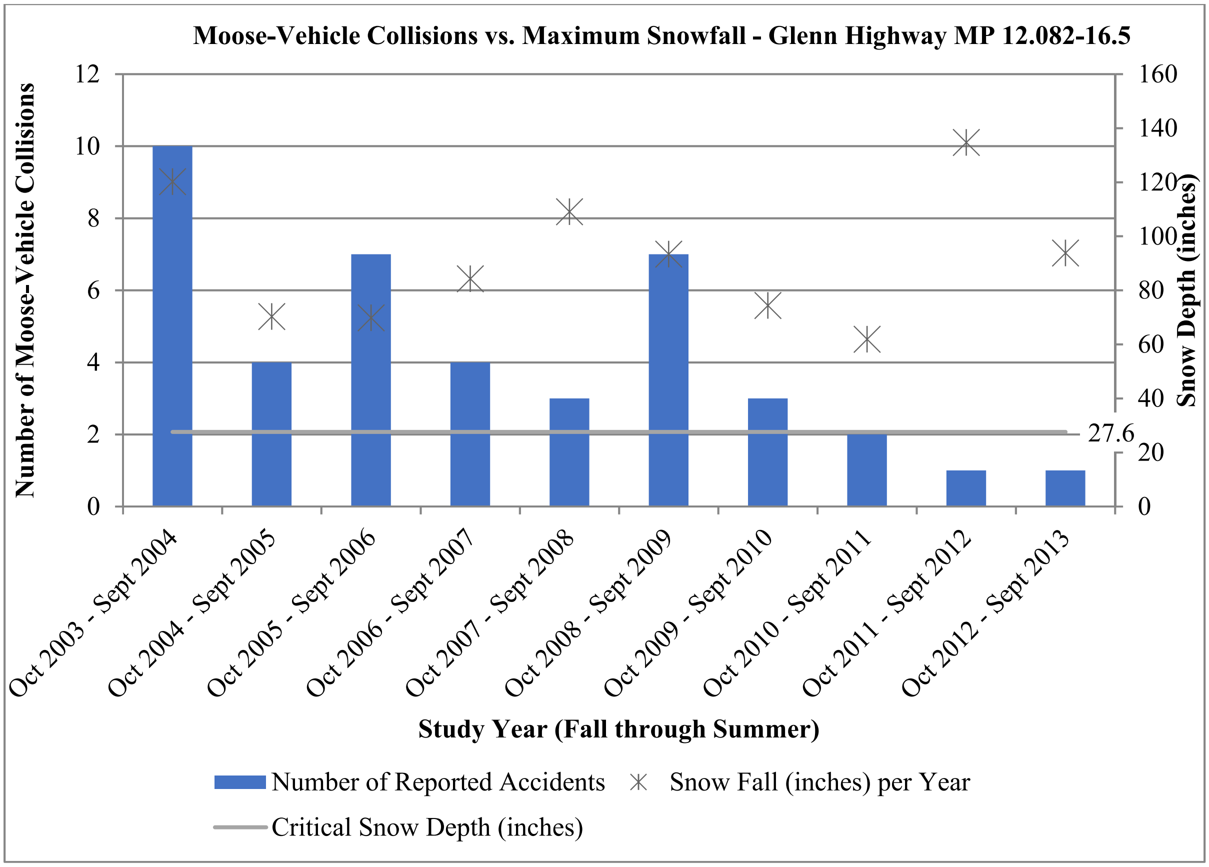

Figure A.18. Moose-Vehicle Collisions vs. Snowfall

Appendix A.7. Parks Highway MP 35–37

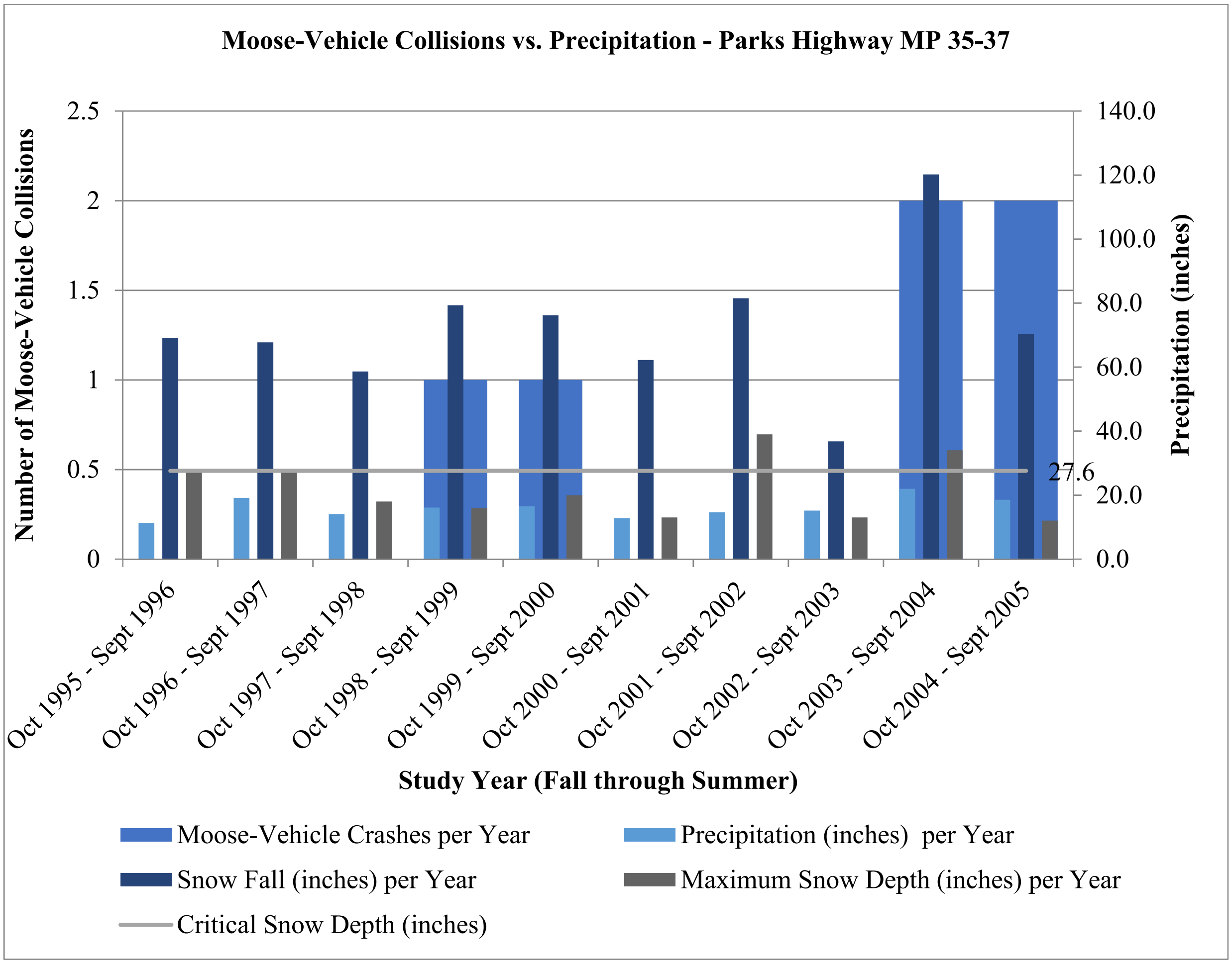

Figure A.19. Moose-Vehicle Collisions vs. Precipitation

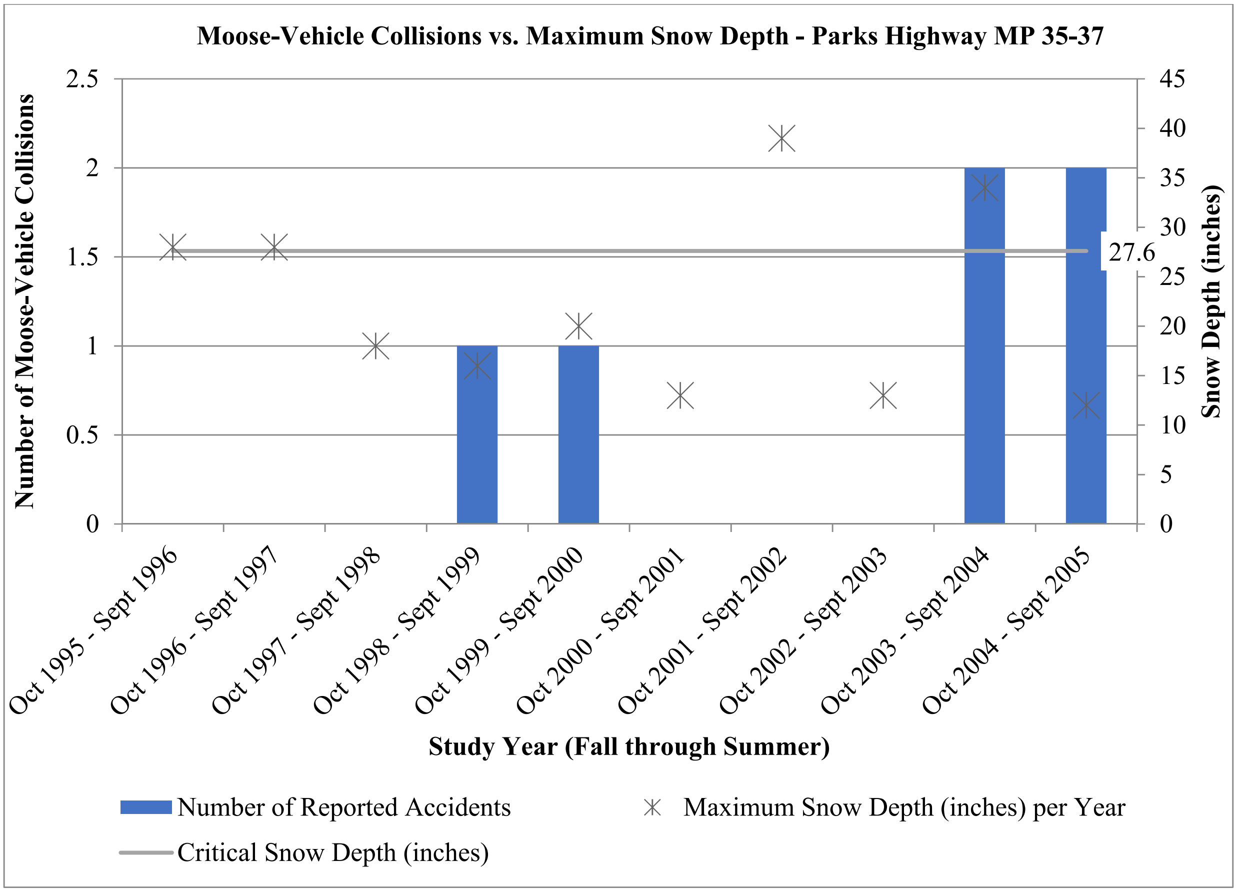

Figure A.20. Moose-Vehicle Collisions vs. Maximum Snow Depth

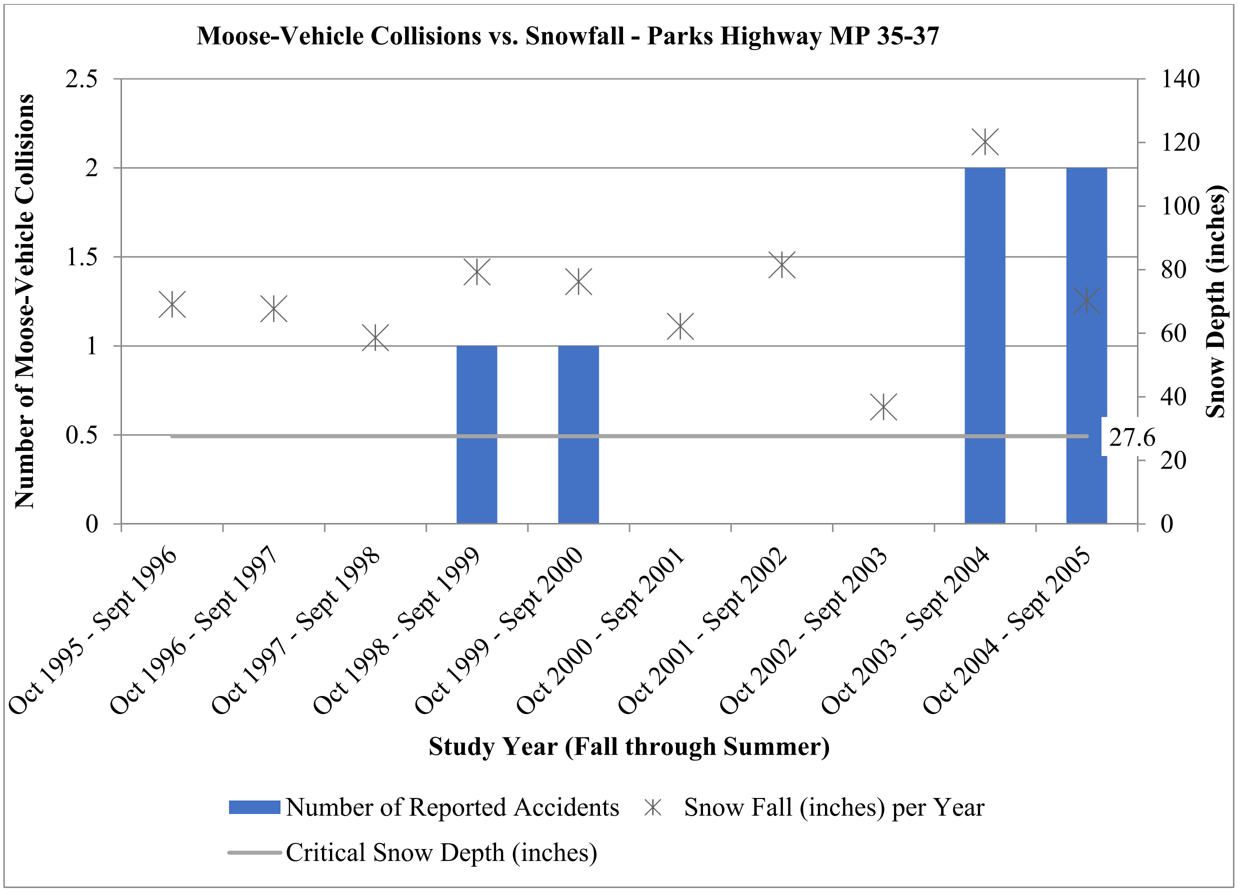

Figure A.21. Moose-Vehicle Collisions vs. Snowfall

Appendix A.8. Parks Highway MP 37–39

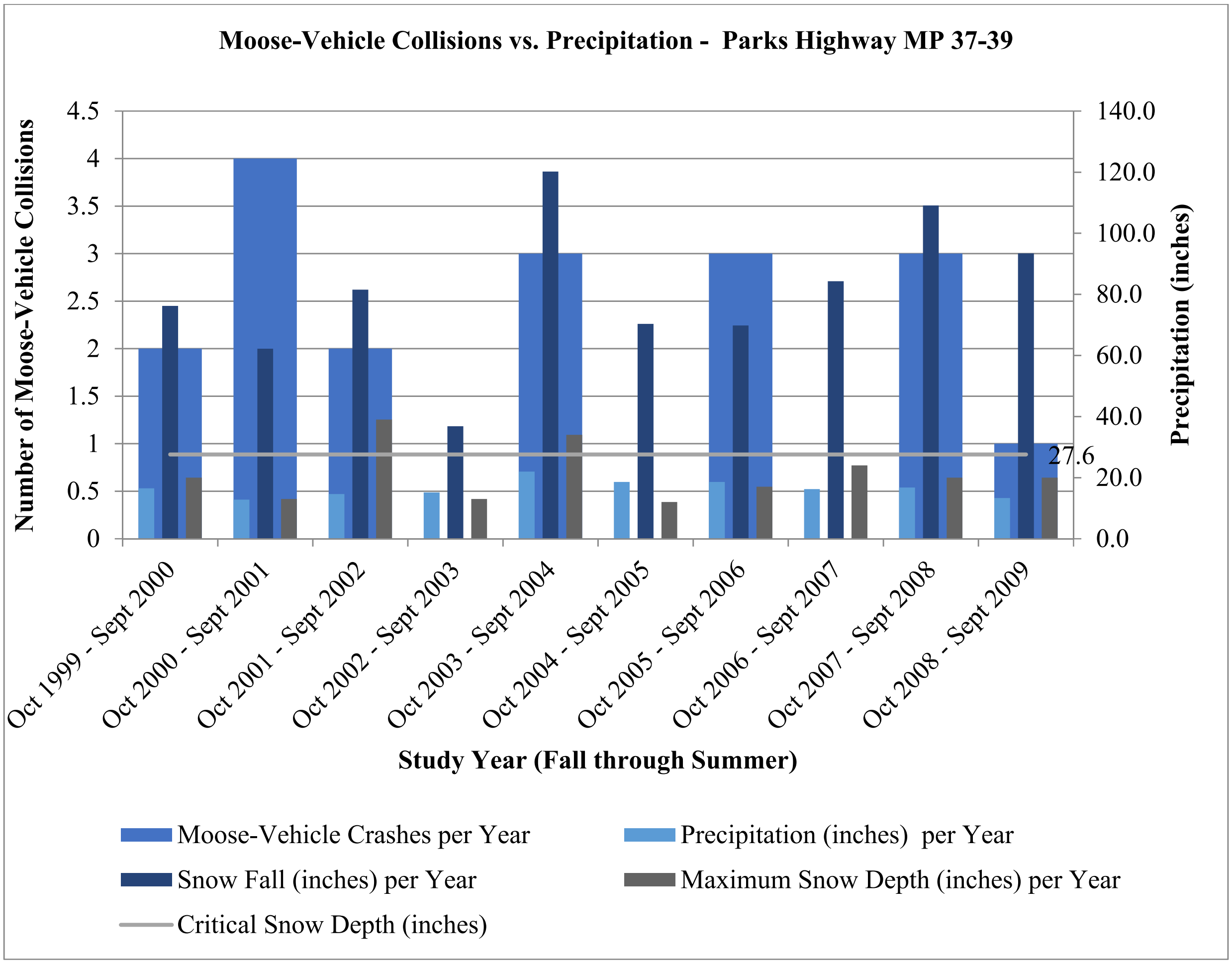

Figure A.22. Moose-Vehicle Collisions vs. Precipitation

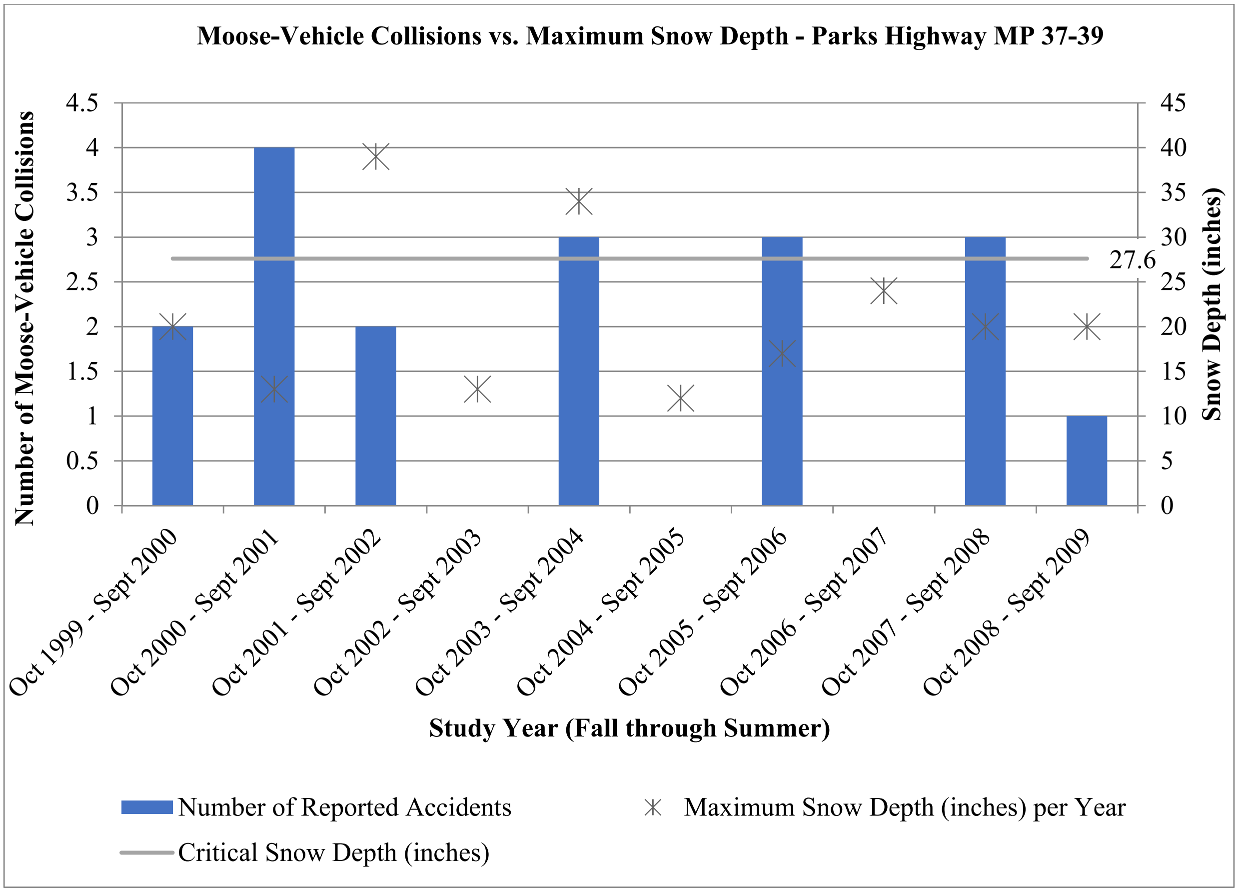

Figure A.23. Moose-Vehicle Collisions vs. Maximum Snow Depth

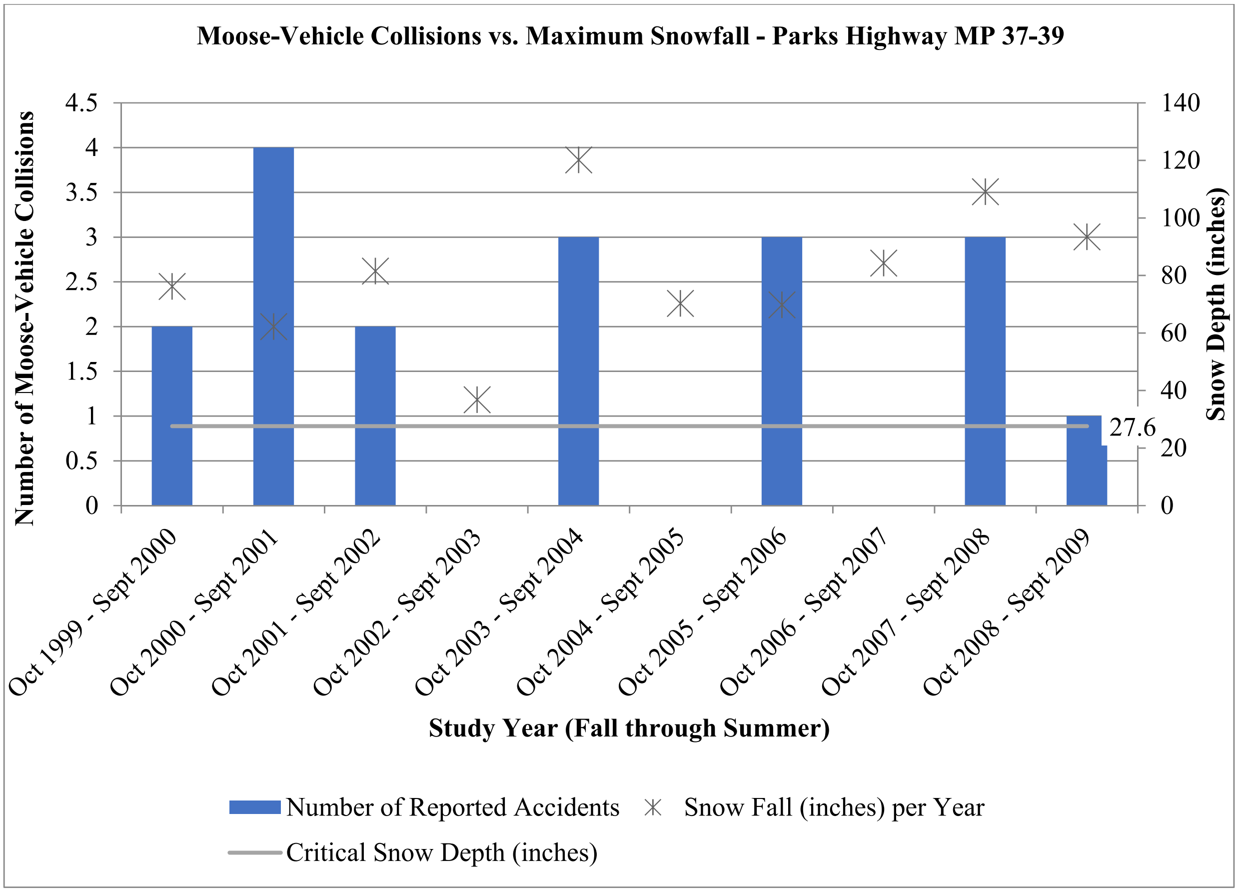

Figure A.24. Moose-Vehicle Collisions vs. Snowfall

Appendix A.9. Parks Highway MP 72–83

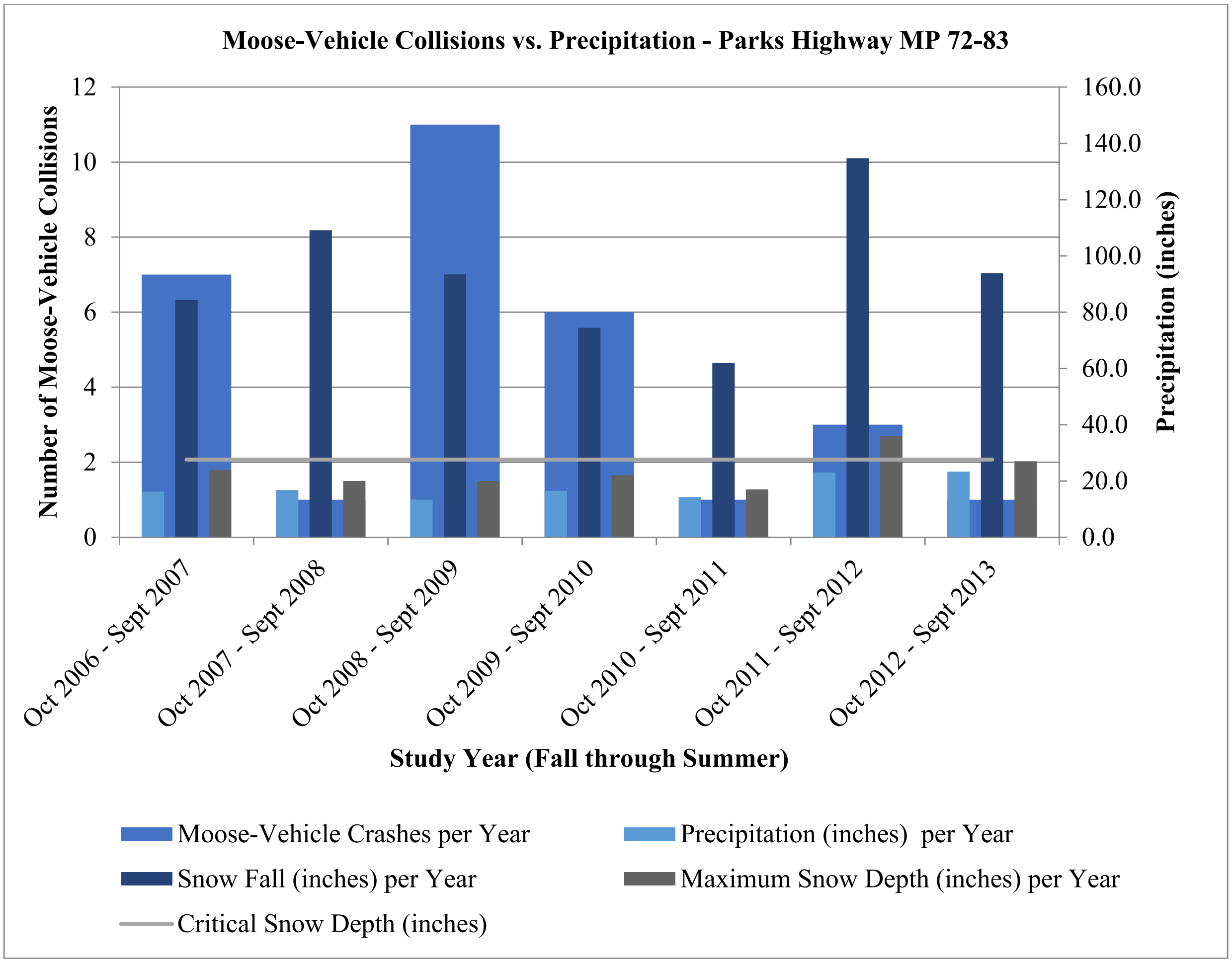

Figure A.25. Moose-Vehicle Collisions vs. Precipitation

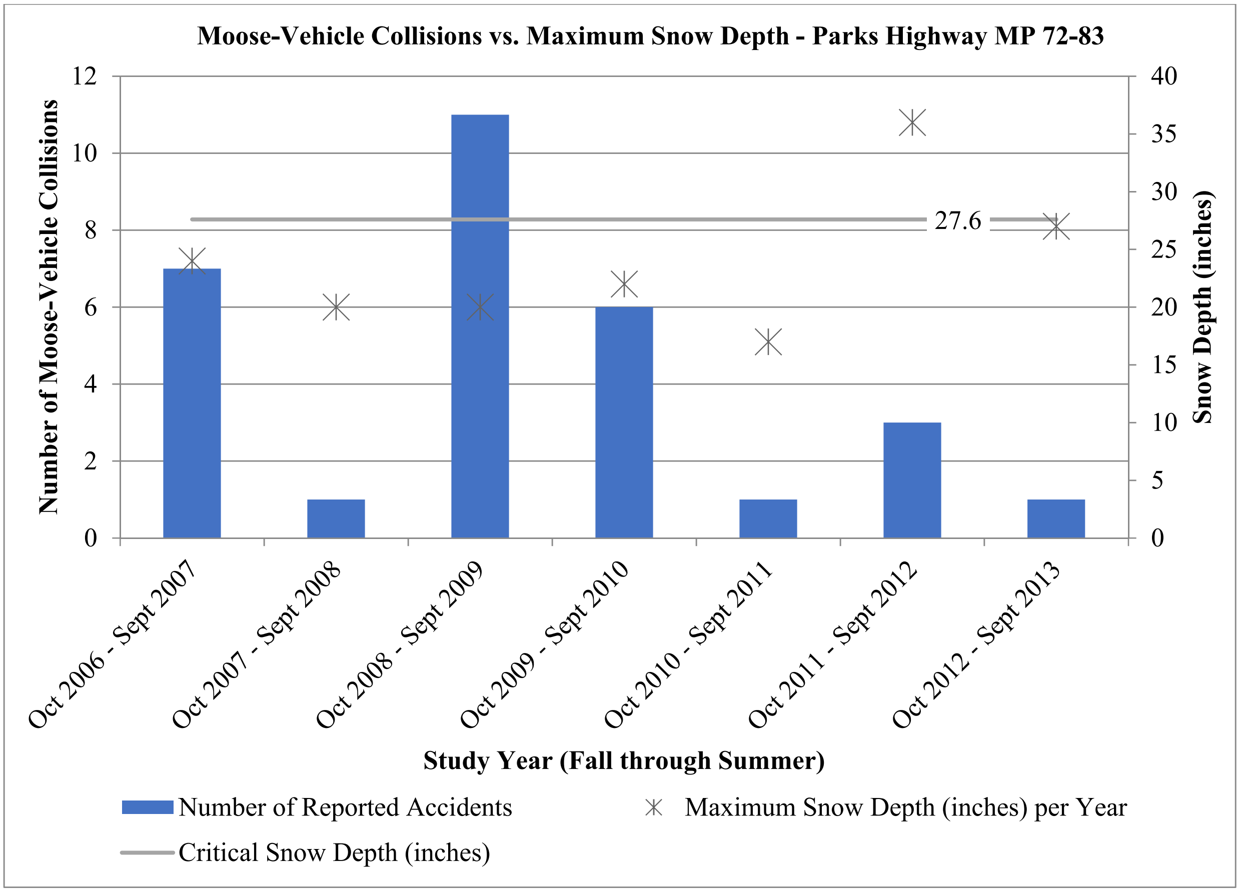

Figure A.26. Moose-Vehicle Collisions vs. Maximum Snow Depth

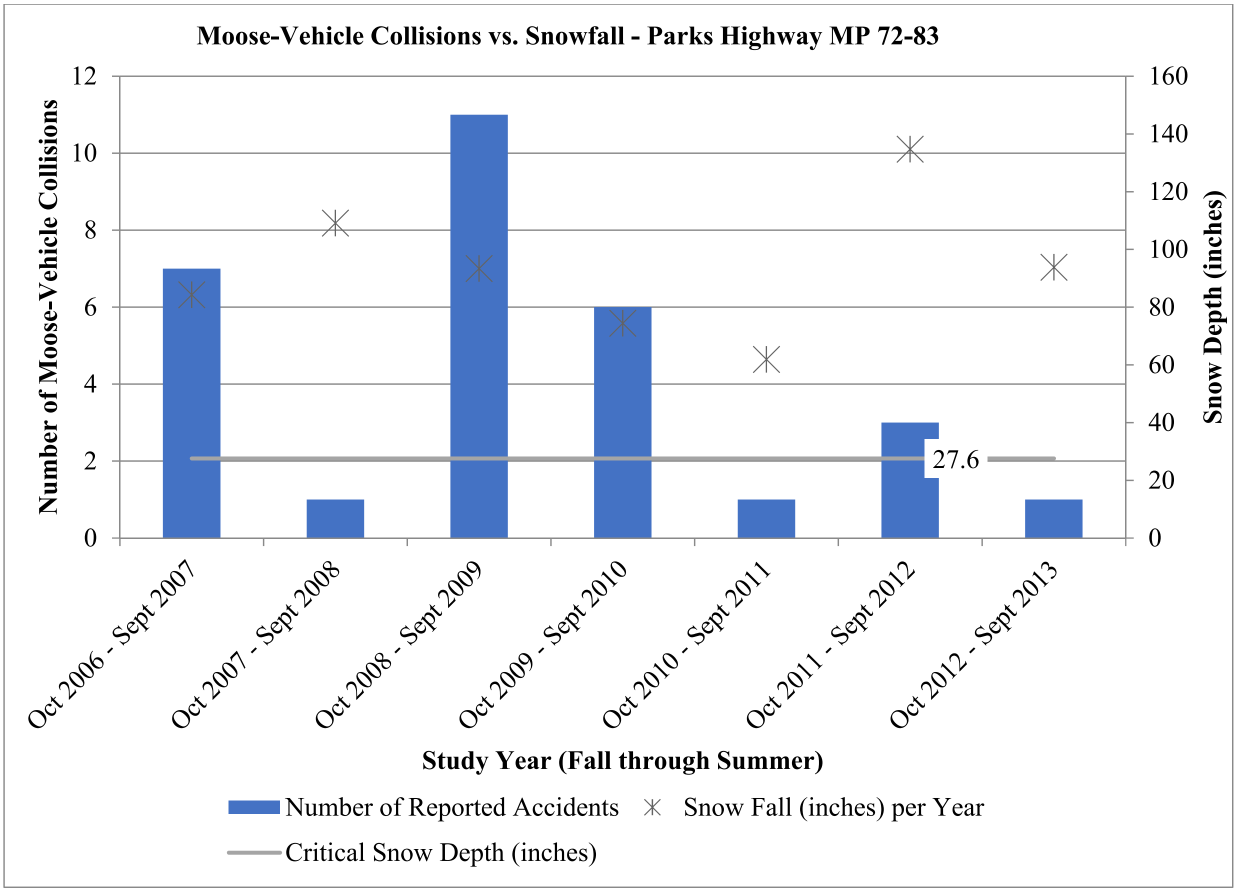

Figure A.27. Moose-Vehicle Collisions vs. Snowfall

Appendix A.10. Knik-Goose Bay Road MP 0.0–19.56

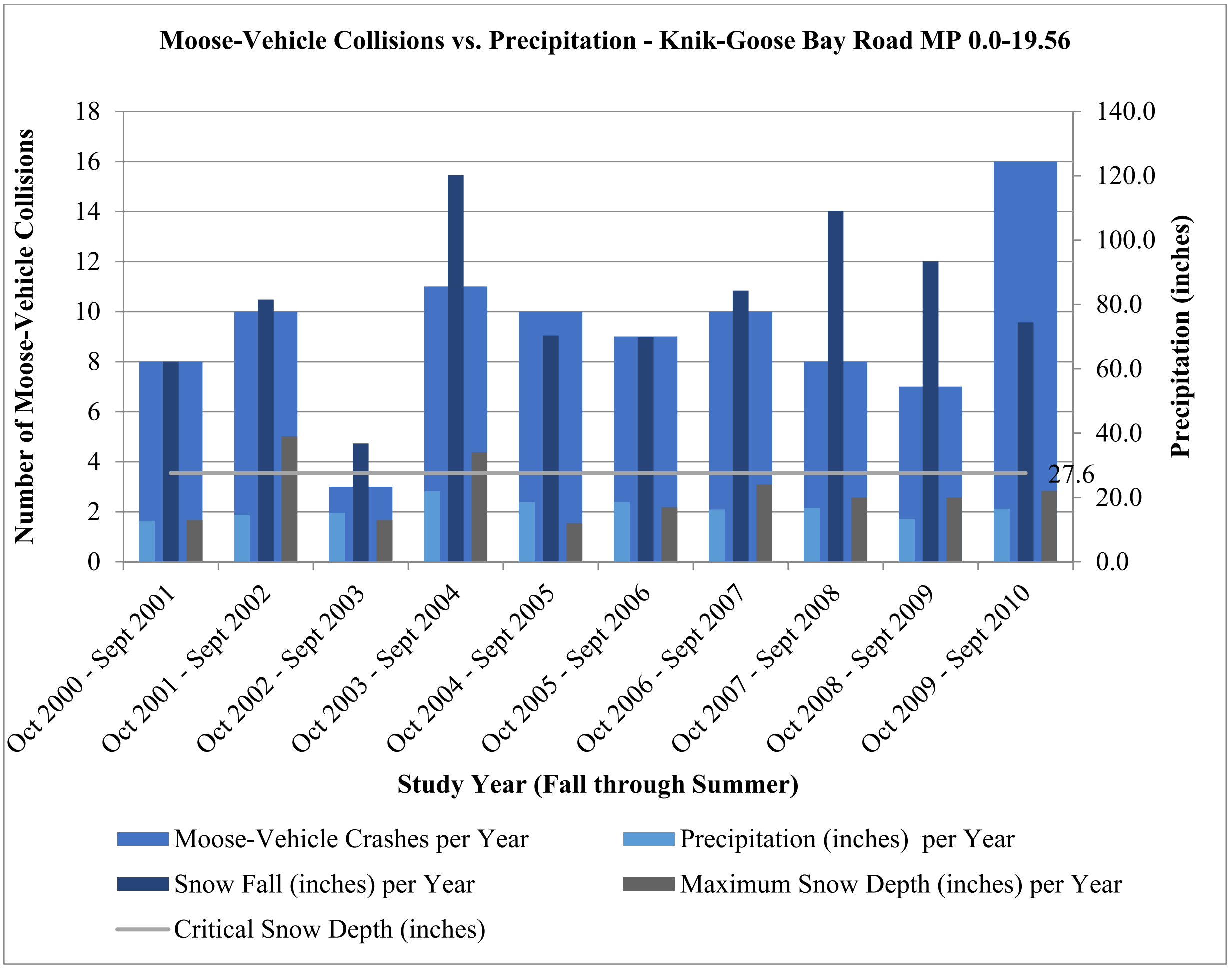

Figure A.28. Moose-Vehicle Collisions vs. Precipitation

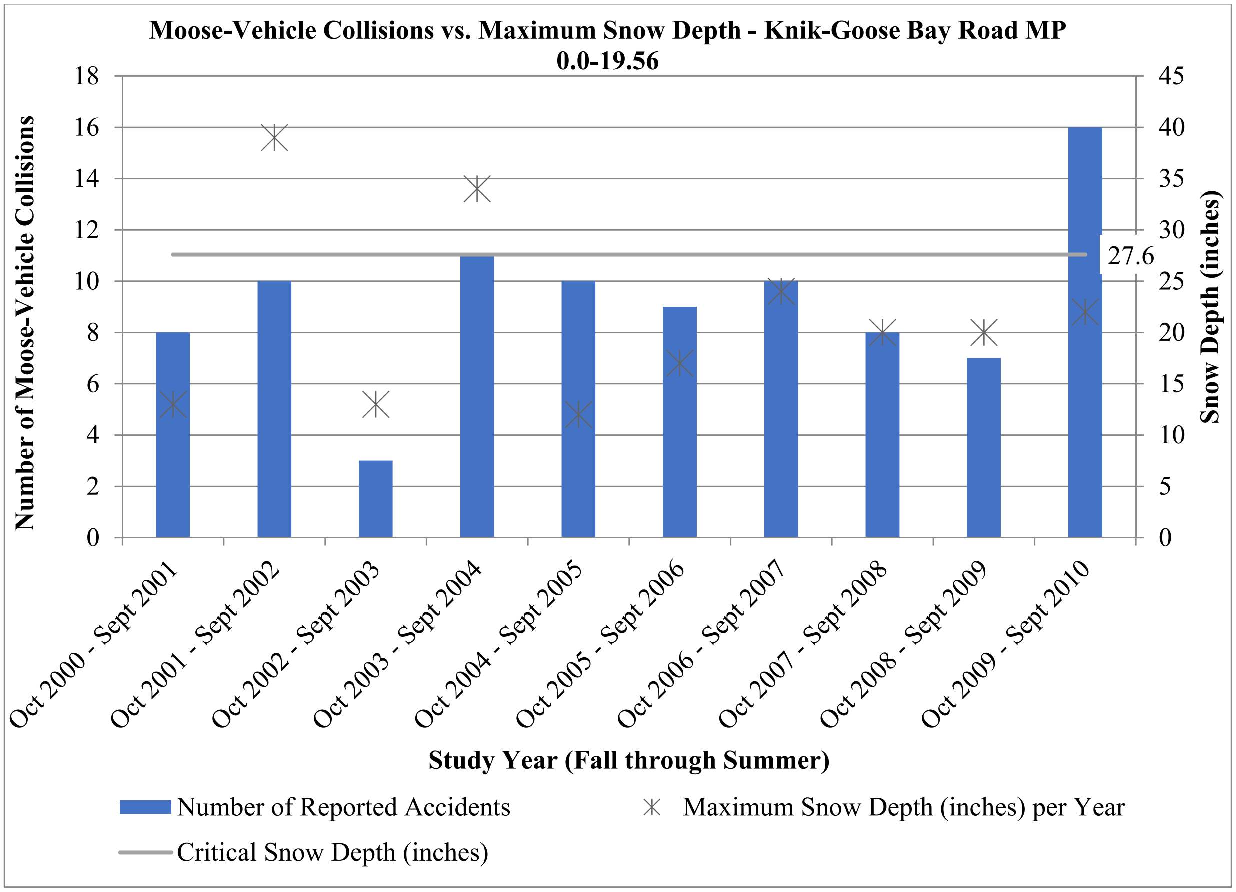

Figure A.29. Moose-Vehicle Collisions vs. Maximum Snow Depth

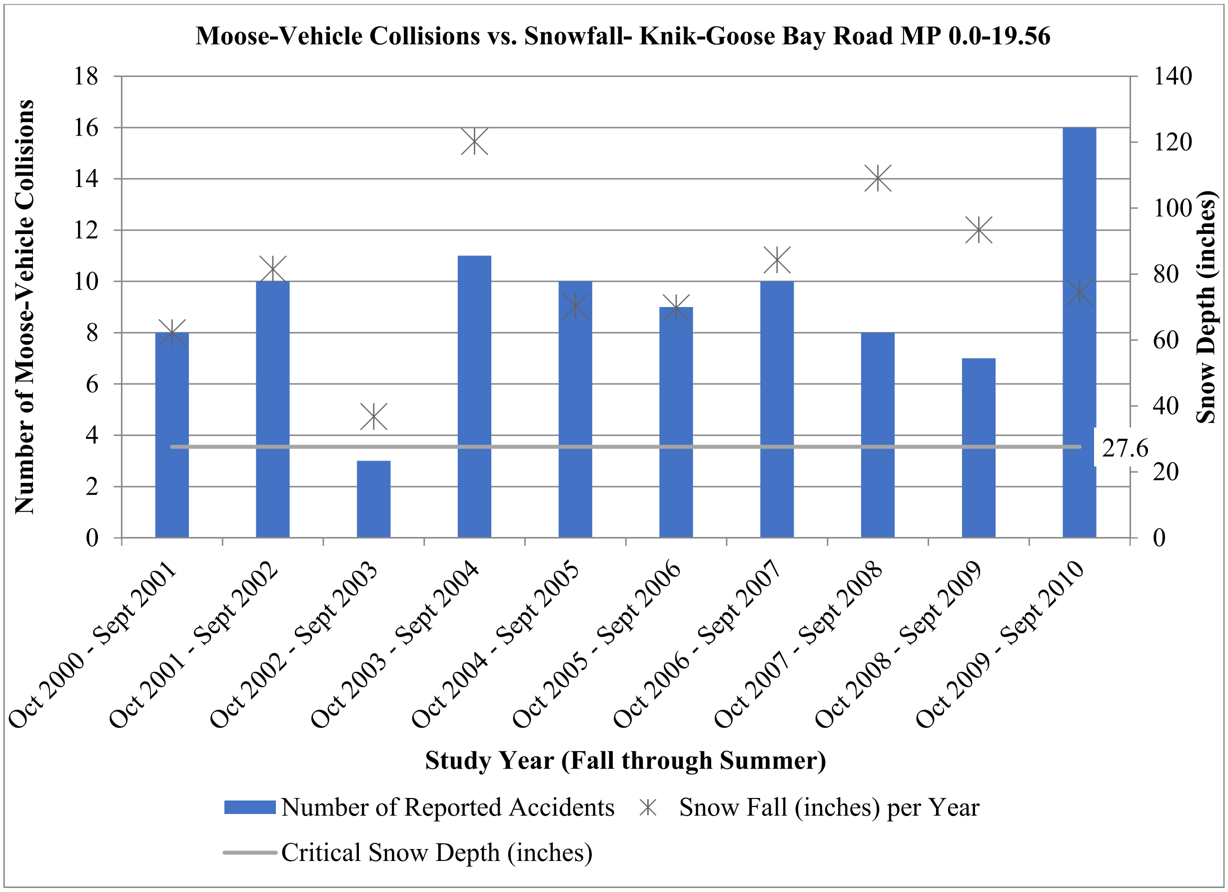

Figure A.30. Moose-Vehicle Collisions vs. Snowfall

Appendix B

Moose Population from Moose Management Reports and from the Alaska Department of Fish and Game (ADF&G)

Figures B.1 through B.10 are maps of the Game Management Units for each study corridor and were taken from the ADF&G Moose Management Reports. They are provided for information purposes only. Figure B.11 shows a sample of the moose population tables from the ADF&G Moose Management Reports referenced for the collection of moose population for each study corridor.

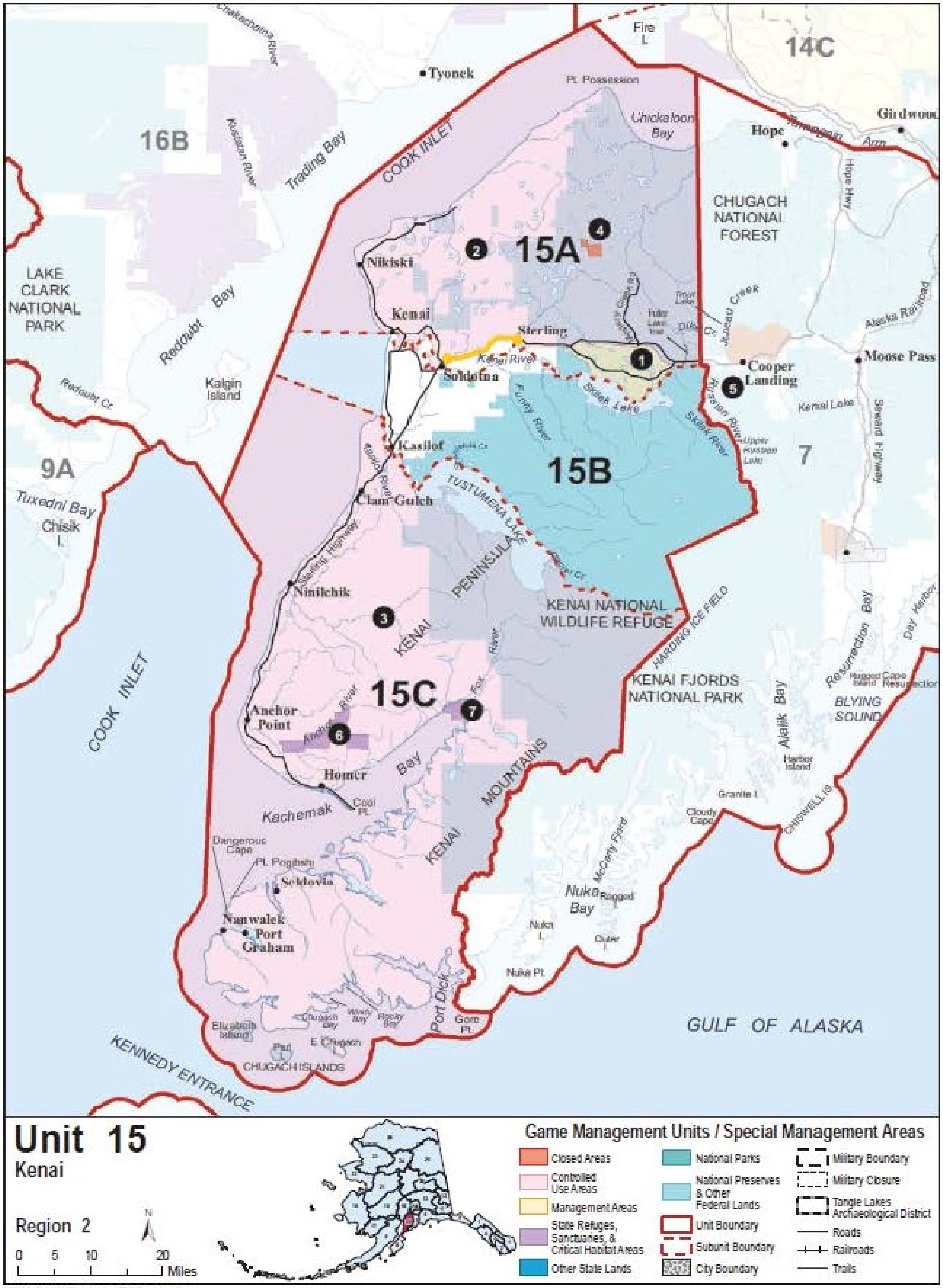

Figure B.1. Moose Game Management Unit 15A - Sterling Highway Milepost MP 82.0–93.72

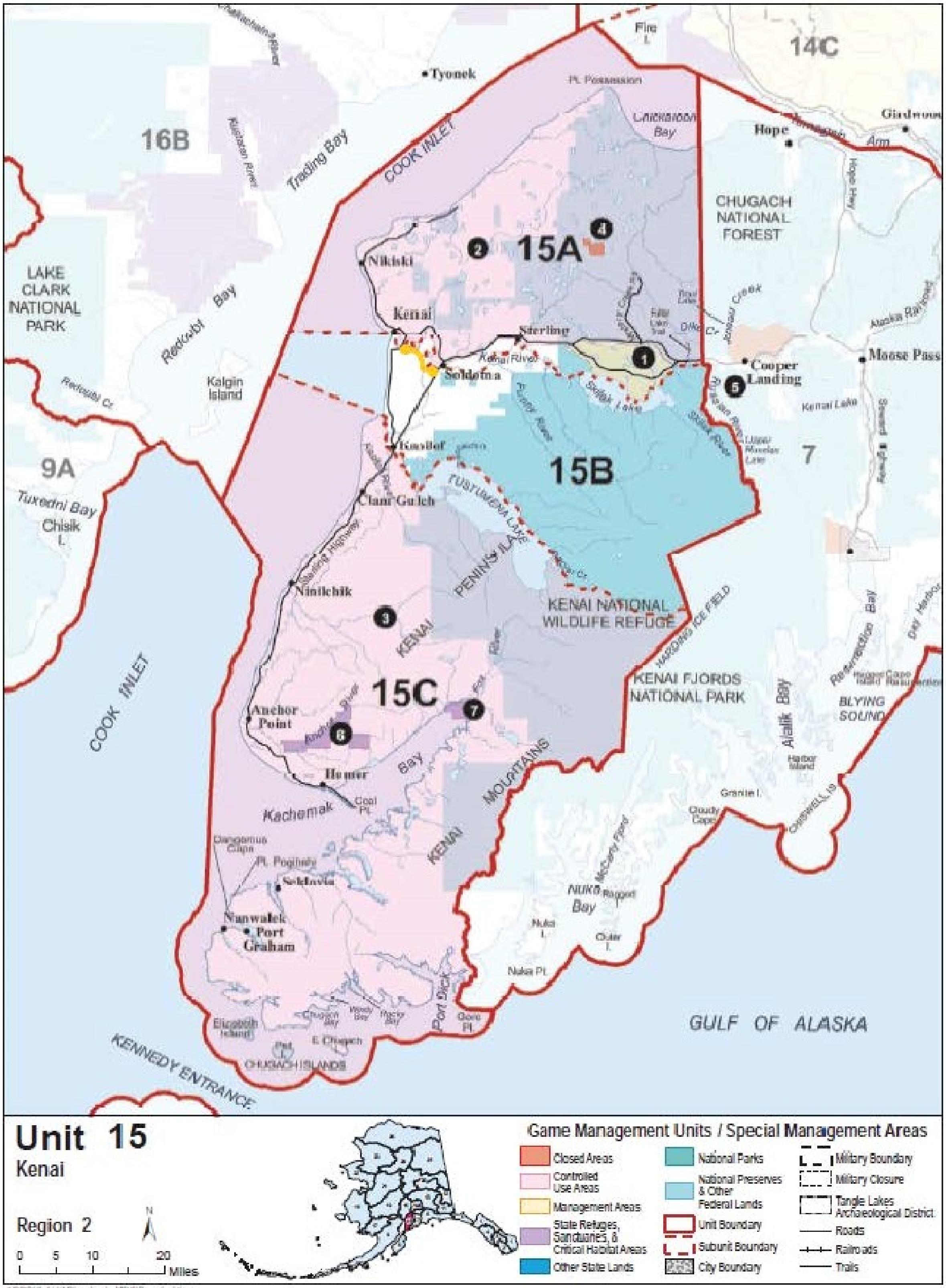

Figure B.2. **Moose Game Management Unit 15B - Kalifornsky Beach Road MP 16.4–22.4**

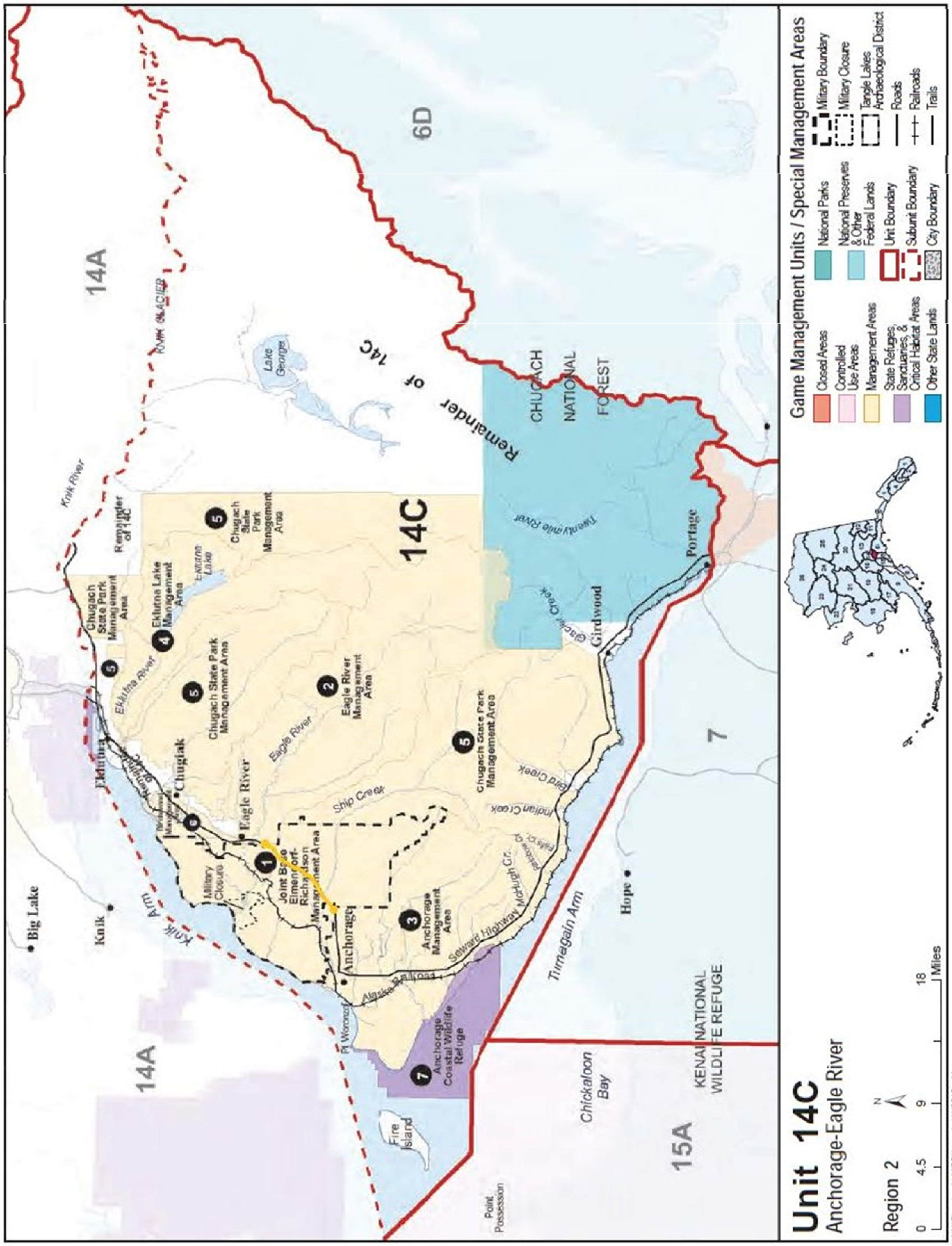

Figure B.3. **Moose Game Management Unit 14C - Glenn Highway MP 4–11**

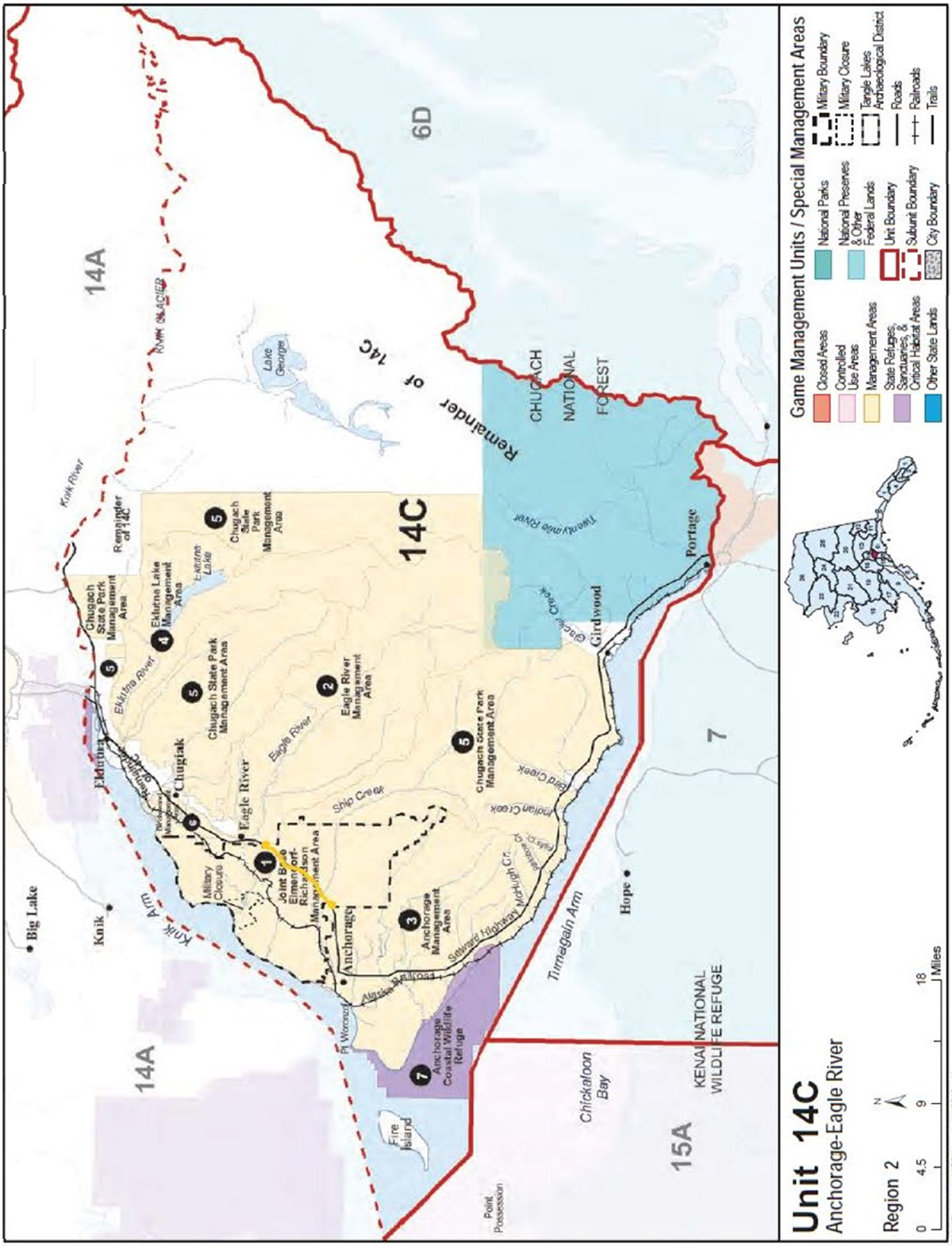

Figure B.4. **Moose Game Management Unit 14C - Glenn Highway MP 3.24–11.46**

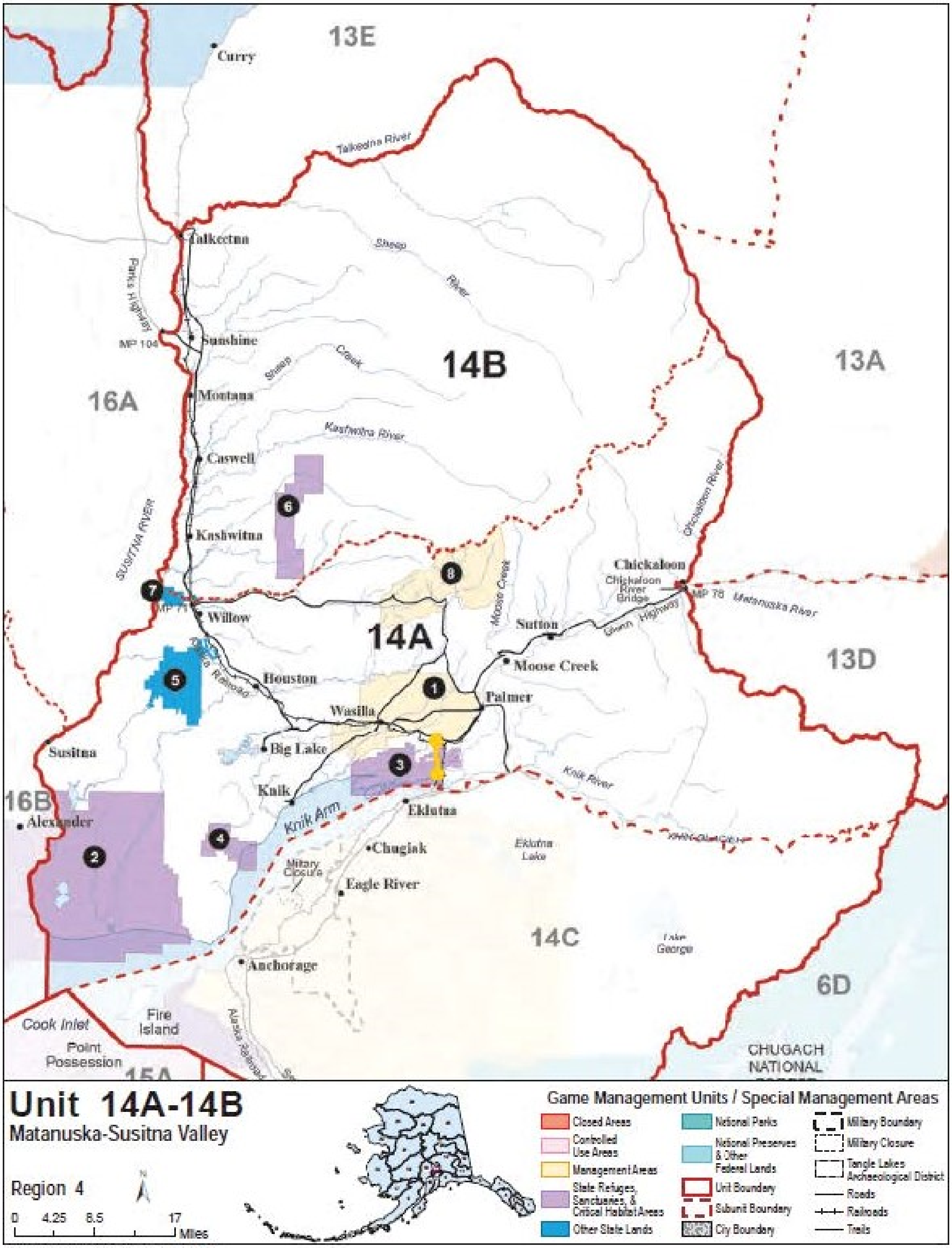

Figure B.5. **Moose Game Management Unit 14A - Glenn Highway MP 30.7–33.5**

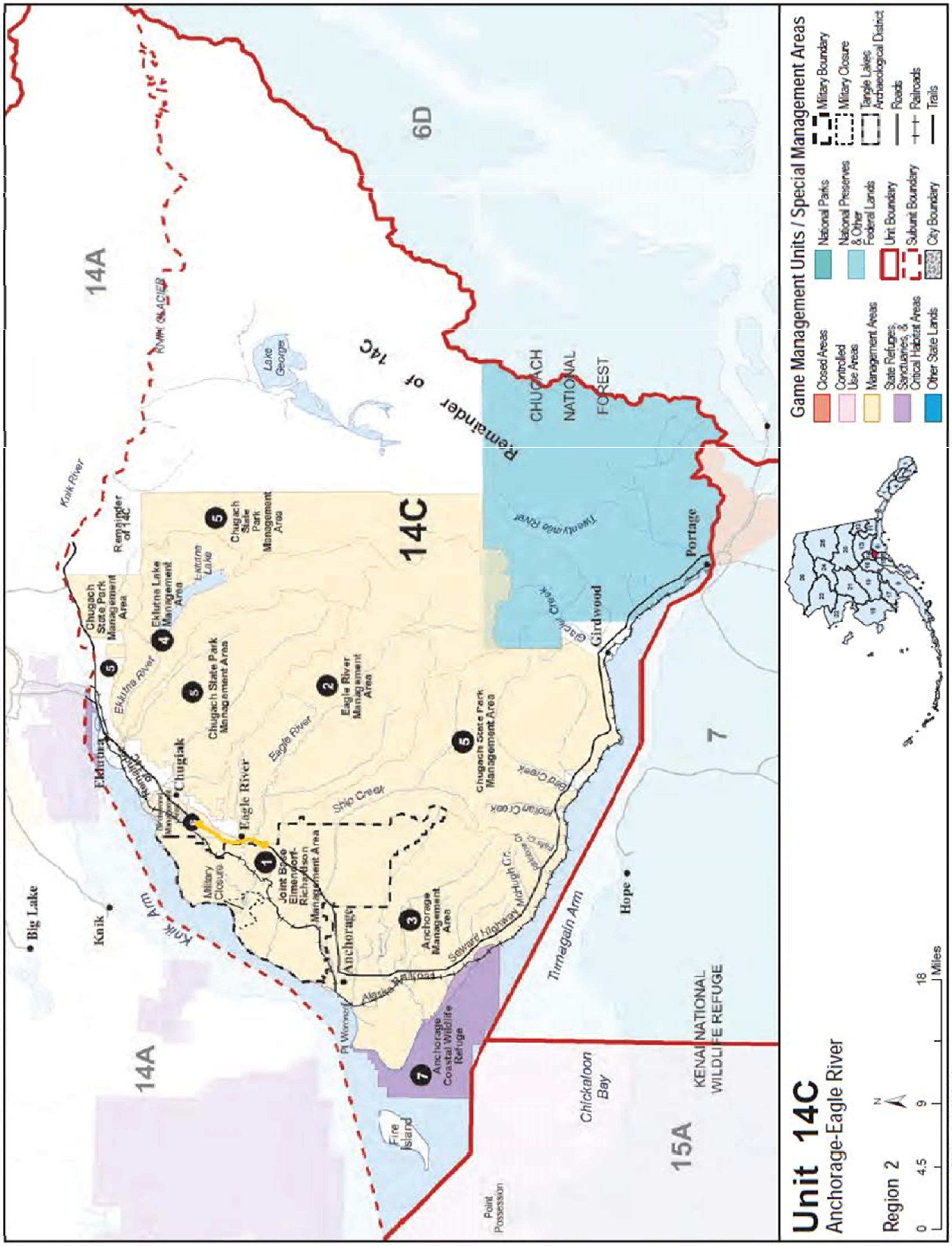

Figure B.6. **Moose Game Management Unit 14C - Glenn Highway MP 12.082–16.5**

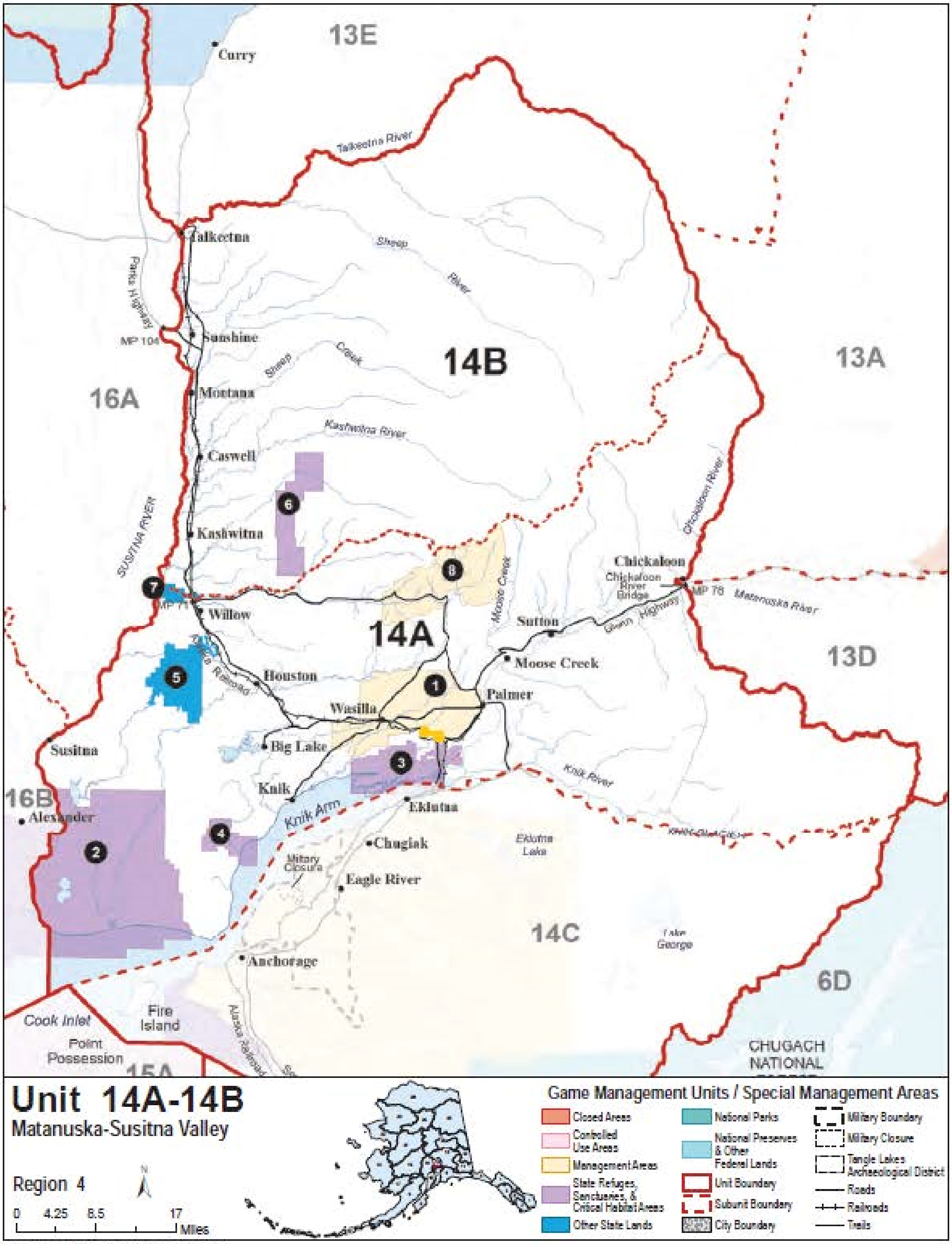

Figure B.7. Moose Game Management Unit 14A - Parks Highway MP 35–37

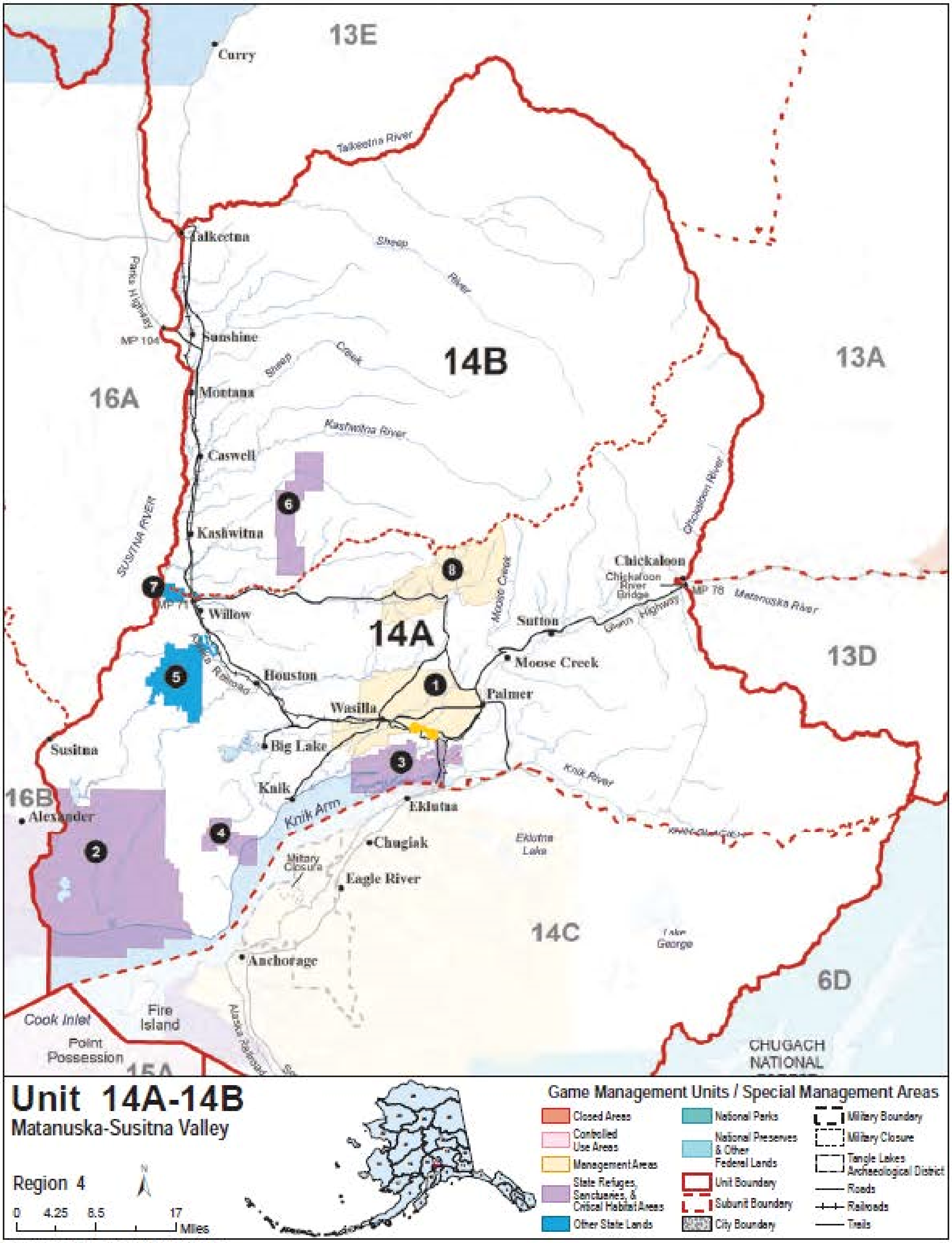

Figure B.8. Moose Game Management Unit 14A - Parks Highway MP 37–39

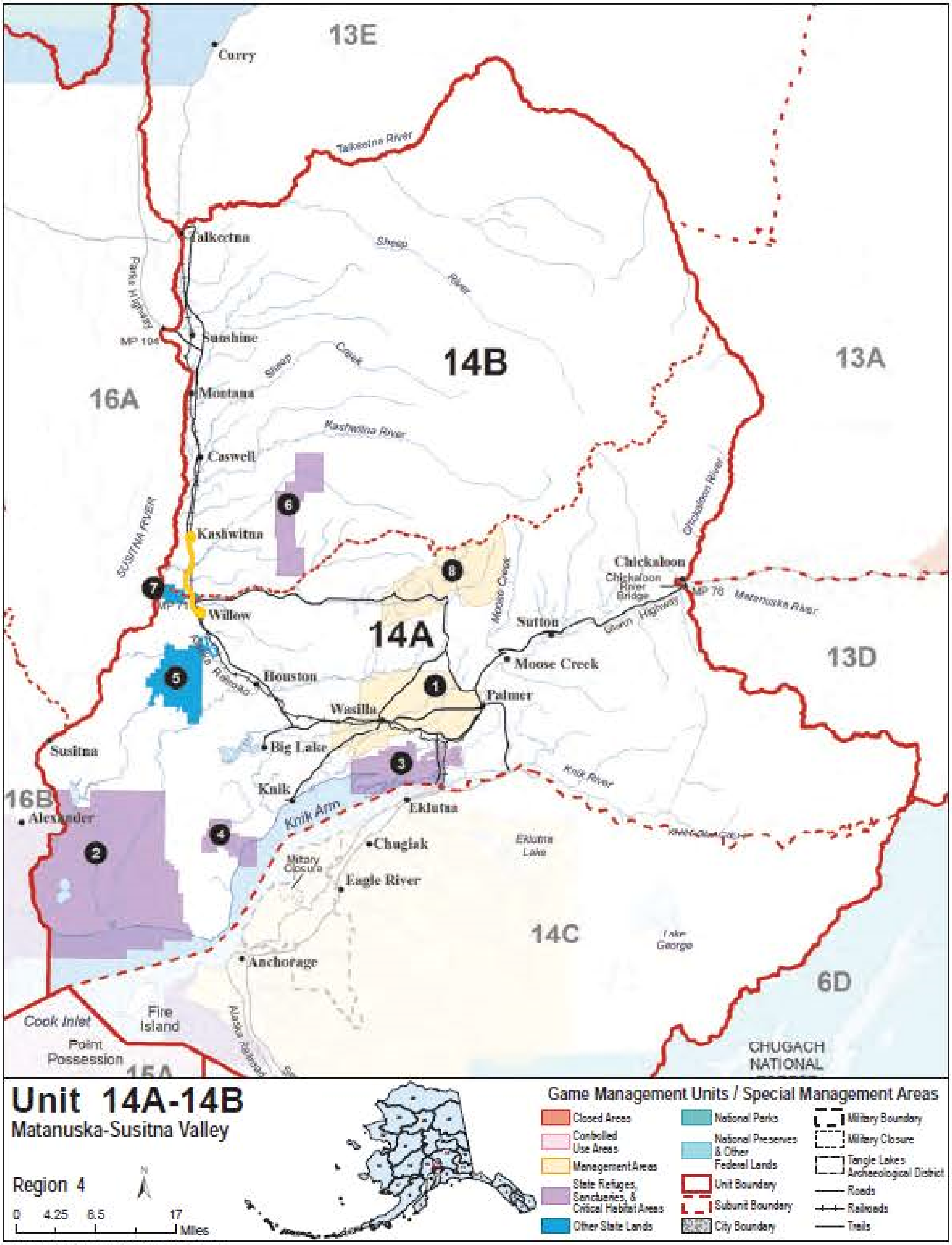

Figure B.9. Moose Game Management Unit 14B - Parks Highway MP 72–83

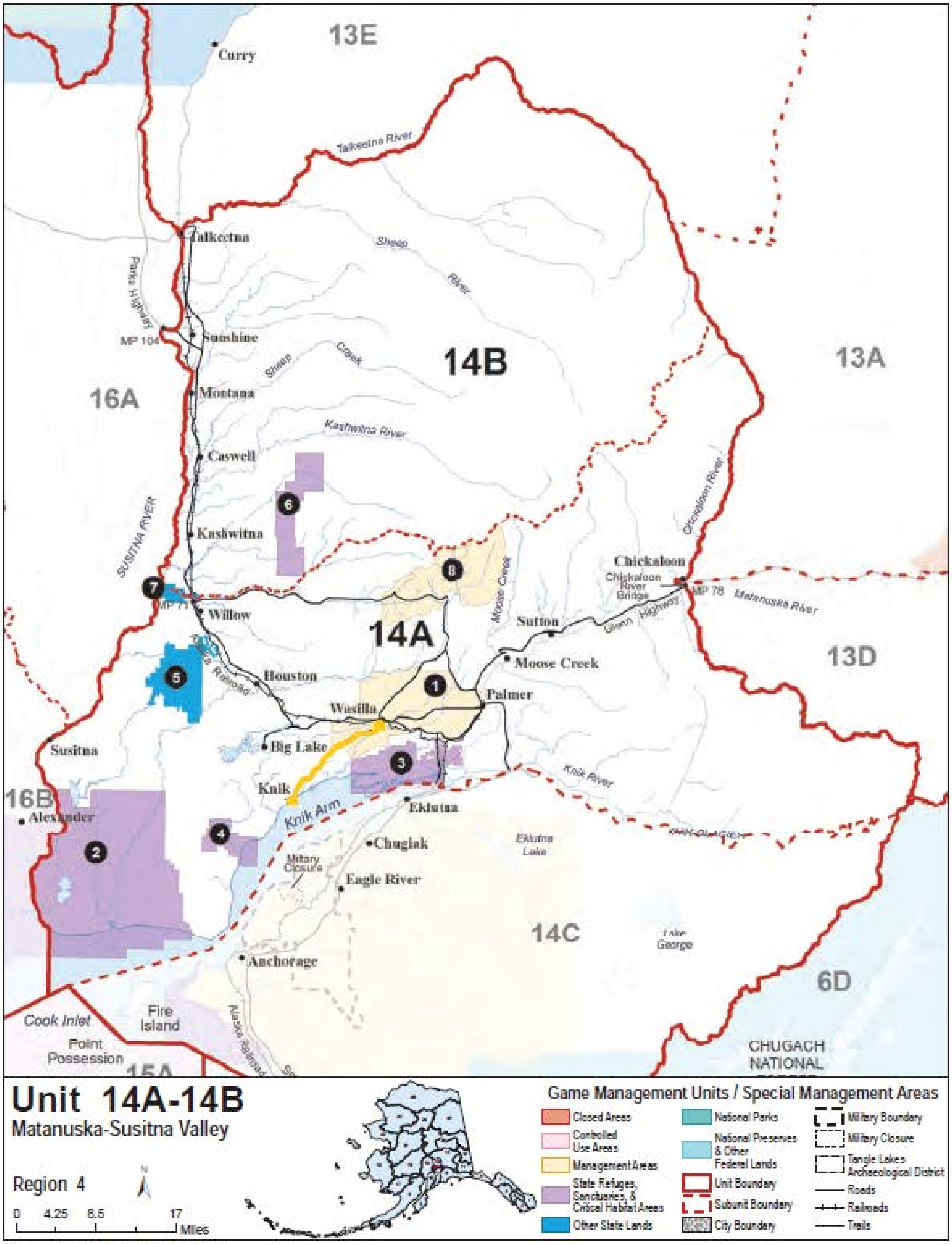

Figure B.10. Moose Game Management Unit 14A - Knik-Goose Bay Road MP 0.0–19.56

Table 1. Subunit 15A aerial moose composition counts and estimated population size, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1986/87[a]								
1987/88	16	6	38	25	784	1,026	46	2,702
1988/89	18	7	45	28	835	1,155	78	--
1989/90	22	7	36	23	1,340	1,737	57	--
1990/91	23	3	35	22	1,231	1,580	--	3,432

[a] No data available.

Table 2. Subunit 15A moose harvest[a] and accidental death, 1986-91.

Regulatory	Hunter Harvest										
	Reported				Estimated			Accidental death			Grand
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	total
1986/87	285	22	29	366			40	112		112	518
1987/88	131	3	16	150			40	114		114	304
1988/89	140	0	16	156			40	135		135	311
1989/90	178	0	3	181			40	205		205	426
1990/91	92	2	2	97			40	119		119	256

[a] Excludes permit hunt harvest.

Figure B.11. Tables 1 and 2 from the ADF&G 1 July 1989 – 30 June 1991 Moose Management Report for Game Management Unit 15A (ADF&G, 1989–2011)

Appendix C

Crash Data

Table C.1 is a sample of the moose-vehicle crash data information collected for the Sterling Highway Milepost MP 82.0–93.72 corridor for this project and was developed from the DOT&PF crash database. This table is provided for information purposes only.

Table C.1. Crash Data for Sterling Highway Milepost MP 82.0–93.72

ACCNUM	ACCDATE	ACCTIME	CDSRTE	ACCMIPT
198614055	19861013	1921	110000	53.814
198614535	19861022	210	110000	52.736
198617332	19861209	1642	110000	53.552
198701851	19870131	2316	110000	53.575
198702295	19870205	2026	110000	47.692
198702499	19870211	2201	110000	54.925
198712140	19871018	2239	110000	53.575
198714024	19871122	1951	110000	52.269
198716342	19871125	1805	110000	53.651
198776794	19871202	1748	110000	52.633
198714992	19871208	1733	110000	54.926
198715722	19871216	2315	110000	54.888
198716595	19871230	2343	110000	53.999
198800192	19880105	1825	110000	53.999
198800530	19880110	1733	110000	53.992
198801687	19880202	2100	110000	47.398
198801893	19880206	1830	110000	48.769
198803402	19880308	1945	110000	54.926
198811831	19881007	115	110000	54.924
198810539	19881009	2020	110000	53.999
198812320	19881017	751	110000	54.926
198812864	19881026	50	110000	54.921
198814662	19881130	630	110000	54.001
198816048	19881221	713	110000	49.247
198900348	19890107	840	110000	54.925
198901248	19890119	2200	110000	53.575
198901357	19890121	2200	110000	54.926
198901585	19890123	510	110000	54.912
198901733	19890125	1900	110000	47.653
198902020	19890129	2000	110000	54.906
198902405	19890203	810	110000	55.628
198902594	19890205	953	110000	51.681
198902698	19890207	621	110000	49.378
198905061	19890328	2013	110000	49.247
198907400	19890527	15	110000	49.621
198908844	19890714	355	110000	47.791
198909066	19890719	246	110000	52.601
198909379	19890726	57	110000	55.437
198909486	19890729	145	110000	52.834
198910459	19890820	600	110000	52.28
198911278	19890906	2159	110000	53.999
198912714	19891010	2107	110000	54.925
198916063	19891205	1745	110000	55.609
198916137	19891206	650	110000	47.791
198916255	19891208	2017	110000	54.92
198916724	19891213	1819	110000	53.992
198916847	19891215	2115	110000	54.926
198917066	19891218	324	110000	53.814
198917831	19891226	2015	110000	51.003

Table C.1. Crash Data for Sterling Highway Milepost MP 82.0–93.72 (Continued)

ACCNUM	ACCDATE	ACCTIME	CDSRTE	ACCMIPT
199000116	19900102	2058	110000	51.016
199000741	19900110	2130	110000	51.526
199000917	19900112	1917	110000	51.526
199001323	19900118	2240	110000	54.924
199001623	19900122	830	110000	53.814
199005101	19900205	1840	110000	53.552
199003494	19900216	1805	110000	55.628
199005040	19900305	0	110000	47.398
199007913	19900329	2120	110000	47.398
199009859	19900624	1553	110000	51.526
199010592	19900714	215	110000	52.601
199011795	19900804	430	110000	53.575
199015332	19900820	2240	110000	54.888
199013415	19900909	600	110000	49.012
199014046	19900924	1615	110000	54
199014267	19900929	2155	110000	52.767
199015482	19901023	753	110000	55.419
199018735	19901211	2304	110000	54
199100736	19910110	2020	110000	51.435
199100758	19910111	2230	110000	53.202
199103533	19910220	10	110000	50.359
199103551	19910221	400	110000	50.359
199107467	19910523	1130	110000	55.702
199109734	19910706	0	110000	55.291
199111817	19910819	2255	110000	52.723
199114181	19911007	606	110000	55.058
199115784	19911105	1856	110000	51.464
199115787	19911106	2112	110000	51.464
199115866	19911109	1812	110000	53.049
199116122	19911114	1916	110000	50.837
199119565	19911114	1045	110000	55.058
199117463	19911204	230	110000	54.018
199117934	19911210	825	110000	51.004
199118496	19911218	1800	110000	52.723
199118868	19911221	1719	110000	53.049
199119123	19911225	0	110000	55.518
199200129	19920103	132	110000	55.411
199200304	19920106	1843	110000	54.941
199200508	19920110	745	110000	55.702
199202200	19920203	1800	110000	56.474
199204310	19920217	1930	110000	50.359
199206872	19920401	550	110000	53.049
199208807	19920611	130	110000	56.474
199211370	19920808	2347	110000	54.92
199211491	19920811	1020	110000	50.037
199215438	19920928	2145	110000	47.821
199214870	19921018	1939	110000	52.531
199216366	19921112	1820	110000	47.85
199304101	19930203	1830	110000	50.539
199303782	19930222	1950	110000	52.774

Table C.1. Crash Data for Sterling Highway Milepost MP 82.0–93.72 (Continued)

ACCNUM	ACCDATE	ACCTIME	CDSRTE	ACCMIPT
199310434	19930806	2345	110000	52.218
199317236	19931008	735	110000	53.049
199313236	19931010	2154	110000	55.985
199318312	19931016	1930	110000	52.723
199314371	19931031	1915	110000	56.007
199314500	19931103	2135	110000	52.218
199314846	19931110	550	110000	53.049
199315678	19931124	735	110000	54.695
199315983	19931129	1730	110000	47.692
199316789	19931211	1752	110000	51.714
199400587	19940112	2020	110000	55.058
199400816	19940116	895	110000	53.964
199402601	19940215	1943	110000	55.985
199403008	19940301	1915	110000	53.813
199410585	19940507	2350	110000	53.055
199409788	19940730	35	110000	53.049
199409789	19940730	30	110000	53.049
199413680	19941021	2050	110000	54.648
199414192	19941029	1920	110000	52.107
199414504	19941103	1838	110000	49.836
199415076	19941111	1950	110000	53.582
199415990	19941124	2130	110000	53.055
199419380	19941205	1740	110000	50.359
199417460	19941212	845	110000	51.195
199417644	19941214	1744	110000	49.374
199418544	19941223	1800	110000	51.435
199502567	19950208	2139	110000	55.644
199504772	19950310	2117	110000	55.392
199512766	19950611	2355	110000	53.166
199512768	19950612	200	110000	53.049
199513091	19950918	630	110000	52.218
199514629	19951127	1725	110000	48.814
199517040	19951209	30	110000	53.471
199517836	19951222	2229	110000	55.595
199518099	19951228	2055	110000	51.96
199601710	19960125	1815	110000	53.166
199602011	19960130	1830	110000	55.077
199605880	19960331	1735	110000	52.329
199606467	19960416	1830	110000	54.955
199611757	19960719	13	110000	52.218
199610224	19960810	2305	110000	52.218
199613864	19960920	2057	110000	56.126

Appendix D

Annual Precipitation Data Summaries

Table D.1 summarizes the precipitation information collected from the NOAA Annual Climatological Summary tables collected from weather station KENAI MUNICIPAL AIRPORT, AK US COOP: 504546 for Sterling Highway Milepost MP 82.0–93.72. Figure D.1 is the Annual Climatological Summary for weather station KENAI MUNICIPAL AIRPORT, AK US COOP: 504546 and is shown as a sample of the weather information collected for each project corridor. The table and the Annual Climatological Summary are provided for information purposes only.

Table D.1. Weather Data from Station KENAI MUNICIPAL AIRPORT, AK US COOP: 504546 for Sterling Highway Milepost MP 82.0–93.72

	KENAI MUNICIPAL AIRPORT, AK US COOP:504546				
	Study Year		TPCP	TSNW	MaxSNWDepth
Oct 1986- Sept 1987	1986	1987	20.84	36.7	13
Oct 1987 - Sept 1988	1987	1988	17.79	55.3	24
Oct 1988 - Sept 1989	1988	1989	21.93	60.9	20
Oct 1989 - Sept 1990	1989	1990	28.82	106.8	44
Oct 1990 - Sept 1991	1990	1991	19.29	66.6	26
Oct 1991 - Sept 1992	1991	1992	19.20	116.1	37
Oct 1992 - Sept 1993	1992	1993	19.91	60.0	17
Oct 1993 - Sept 1994	1993	1994	16.90	72.1	23
Oct 1994 - Sept 1995	1994	1995	27.50	119.0	39
Oct 1995 - Sept 1996	1995	1996	16.80	58.5	22
Oct 1996 - Sept 1997	1996	1997	15.46	63.9	26
Oct 1997 - Sept 1998	1997	1998	22.07	57.1	24
Oct 1998 - Sept 1999	1998	1999	22.21	83.1	32
Oct 1999 - Sept 2000	1999	2000	18.22	0.0	0
Oct 2000 - Sept 2001	2000	2001	14.71	0.0	0

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Elev: 91 ft. Lat: 60.580° N Lon: 151.239° W
Station: **KENAI MUNICIPAL AIRPORT, AK US COOP:504546**

Annual Climatological Summary (2015)

Generated on 06/05/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Date	Temperature (F)														Precipitation (inches)									
Elem->	MMXT	MMNT	MNTM	DPNT	HTDD	CLDD	EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP	DPNP	EMXP		TSNW	MXSD		DP01	DP05	DP10
											Number Of Days						Greatest Observed		Snow, Sleet			Number Of Days		
Month	Mean Max.	Mean Min.	Mean	Depart. from Normal	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Max >=90	Max <=32	Min <=32	Min <=0	Total	Depart. from Normal	Day	Date	Total Fall	Max Depth	Max Date	>=.10	>=.50	>=1.0
1	26.6	12.4	19.5	3.1	1404	0	46	15	-12	25		21	28	9	0.30	-0.66	0.24	23				1	0	0
2	31.0	16.1	23.5	3.8	1153	0	44	16	-11	05		14	25	6	0.36	-0.52	0.20	21				1	0	0
3	37.0	20.6	28.8	3.1	1113	0	50	30	-6	14		8	29	5	0.42	-0.22	0.35	06				1	0	0
4	45.8	29.3	37.6	1.4	819	0	55	26	18	13		0	21	0	0.96	0.37	0.27	29				4	0	0
5	54.7	37.4	46.0	0.0	582	0	63	29	27	02		0	6	0	0.78	-0.13	0.26	08				3	0	0
6	63.0	46.0	54.5	2.0	314	5	86	15	37	13		0	0	0	1.12	0.05	0.27	02				3	0	0
7	64.0	48.8	56.4	0.1	257	0	71	24	37	19		0	0	0	1.68	-0.16	0.32	13				7	0	0
8	65.3	44.5	54.9	-0.1	304	0	77	04	35	31		0	0	0	1.34	-1.35	0.42	15				4	0	0
9	53.5	37.7	45.6	-2.5	574	0	65	02	21	24		0	10	0	6.72	3.45	1.08	29				15	5	1
10	46.5	36.0	41.2	6.0	730	0	54	09	19	31		1	9	0	3.62	0.99	0.64	10				9	2	0
11	29.9	16.6	23.3	0.1	1245	0	44	24	-9	17		17	28	5	1.81	0.43	0.84	25				4	1	0
12																								
Annual	47.0*	31.4*	39.2*		8495*	5*	86*	Jun*	-12*	Jan*		61*	156*	25*	19.11*		1.08*	Sep*				52*	8*	1*

Notes

(blank) Data element not reported or missing.
\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.
A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).
B Adjusted total. Monthly value totals based on proportional available data across the entire month.
E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.
T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will equal zero.
Elem Element types are included to provide cross-reference for users of the NCDC CDO system.
Station Station is identified by: COOP ID, Station Name, State

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value.

* Annual value missing; summary value computed from available month values.

Figure D.1. Annual Climatological Summary for Weather Station KENAI MUNICIPAL AIRPORT, AK US COOP: 504546

Appendix E

Statistical Results

Table E.1 summarizes the variable inputs for Data Set 1 for the Sterling Highway MP 82.0-93.72 corridor. Figure E.1 is the summary output of the regression analysis performed for the Sterling Highway MP 82.0-93.72 corridor. Table E.1 and Figure E.1 are provided as an example of the result outputs produced during the regression analysis process and are provided for information purposes only.

Table E.1. Summary of Variables for Data Set 1 - Sterling Highway MP 82.0-93.72

Year	Number of Reported Accidents	Variable 1 Clearing and Grubbing	Variable 2 Moose Population - Linear	Variable 3 Precipitation (inches)	Variable 4 Snowfall (inches)	Variable 5 Max Snow Depth (inches)
Oct 1986 - Sept 1987	6	0	2349	20.84	36.7	13
Oct 1987 - Sept 1988	12	0	2702	17.79	55.3	24
Oct 1988 - Sept 1989	23	0	2945	21.93	60.9	20
Oct 1989 - Sept 1990	24	0	3189	28.82	106.8	44
Oct 1990 - Sept 1991	9	0	3432	19.29	66.6	26
Oct 1991 - Sept 1992	21	1	3400	19.20	116.1	37
Oct 1992 - Sept 1993	5	1	2606	19.91	60.0	17
Oct 1993 - Sept 1994	16	1	2193	16.90	72.1	23
Oct 1994 - Sept 1995	14	1	1780	27.50	119.0	39
Oct 1995 - Sept 1996	11	1	2185	16.80	58.5	22

1 yes
0 no

Regression Statistics	
Multiple R	0.718752074
R Square	0.516604543
Adjusted R Square	-0.087639778
Standard Error	7.098020251
Observations	10

ANOVA

	df	SS	MS	F	Significance F
Regression	5	215.3724341	43.07448681	0.8549597	0.576366083
Residual	4	201.5275659	50.38189148		
Total	9	416.9			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%
Intercept	9.450621687	30.28518703	0.312054262	0.770589018	-74.6345376	93.53578098	-74.6345376
Clearing and Grubbing	-7.356888229	11.15149744	-0.659722003	0.545482535	-38.31840871	23.60463225	-38.31840871
Moose Population - Linear	-1.22412E-05	0.006651063	-0.001840484	0.998619638	-0.018478553	0.018454071	-0.018478553
Precipitation (inches)	-0.419440594	1.110919927	-0.377561499	0.724935508	-3.503848788	2.664967601	-3.503848788
Snowfall (inches)	0.280691939	0.426831785	0.657617236	0.546702827	-0.904383081	1.465766959	-0.904383081
Max Snow Depth (inches)	-0.150262594	0.952484838	-0.157758516	0.882290609	-2.794784462	2.494259273	-2.794784462

RESIDUAL OUTPUT

Observation	Predicted Number of Reported Accidents	Residuals
1	9.028705621	-3.028705621
2	13.87165982	-1.871659819
3	14.30512231	8.694877689
4	20.68965566	3.310344341
5	16.10485659	-7.10485659
6	21.02747216	-0.027472164
7	7.997822958	-2.997822958
8	11.76019164	4.239808357
9	18.07942738	-4.079427376
10	8.135085859	2.864914141

PROBABILITY OUTPUT

Percentile	Number of Reported Accidents
5	5
15	6
25	9
35	11
45	12
55	14
65	16
75	21
85	23
95	24

Figure E.1. Summary Output from the Regression Analysis of Set 1 - Sterling Highway MP 82.0-93.72