Moose Management Report and Plan, Game Management Unit 15:

Report Period 1 July 2010–30 June 2015, and Plan Period 1 July 2015–30 June 2020

Jason Herreman



2018

Moose Management Report and Plan, Game Management Unit 15:

Report Period 1 July 2010–30 June 2015, and Plan Period 1 July 2015–30 June 2020

PREPARED BY:

Jason Herreman Assistant Area Biologist

APPROVED BY:

<u>Cynthia Wardlow</u> Management Coordinator

REVIEWED BY:

Tom Lohuis Research Coordinator

<u>Thomas McDonough</u> Research Biologist

©2018 Alaska Department of Fish and Game

Alaska Department of Fish and Game Division of Wildlife Conservation PO Box 115526 Juneau, AK 99811-5526



Hunters are important founders of the modern wildlife conservation movement. They, along with trappers and sport shooters, provided funding for this publication through payment of federal taxes on firearms, ammunition, and archery equipment, and through state hunting license and tag fees. This funding provided support for Federal Aid in Wildlife Restoration Moose Survey and Inventory Project 1.0.

Species management reports and plans provide information about species that are hunted or trapped and management actions, goals, recommendations for those species, and plans for data collection. Detailed information is prepared for each species every 5 years by the area management biologist for game management units in their areas, who also develops a plan for data collection and species management for the next 5 years. This type of report is not produced for species that are not managed for hunting or trapping or for areas where there is no current or anticipated activity. Unit reports are reviewed and approved for publication by regional management coordinators and are available to the public via the Alaska Department of Fish and Game's public website.

This species management report and plan was reviewed and approved for publication by Cynthia Wardlow, Management Coordinator for Region II for the Division of Wildlife Conservation.

Species management reports and plans are available via the Alaska Department of Fish and Game's public website (www.adfg.alaska.gov) or by contacting Alaska Department of Fish and Game's Division of Wildlife Conservation, PO Box 115526, Juneau, AK 99811-5526; phone: (907) 465-4190; email: dfg.dwc.publications@alaska.gov. The report may also be accessed through most libraries, via interlibrary loan from the Alaska State Library or the Alaska Resources Library and Information Services (www.arlis.org).

Please cite this document as follows:

Herreman, J. 2018. Moose management report and plan, Game Management Unit 15: Report period 1 July 2010–30 June 2015, and plan period 1 July 2015–30 June 2020. Alaska Department of Fish and Game, Species Management Report and Plan ADF&G/DWC/SMR&P-2018-13, Juneau.

The State of Alaska is an Affirmative Action/Equal Opportunity Employer. Contact the Division of Wildlife Conservation at (907) 465-4190 for alternative formats of this publication.

ADF&G does not endorse or recommend any specific company or their products. Product names used in this publication are included for completeness but do not constitute product endorsement.

Contents

| Purpose of this Report | . 1 |
|--|--|
| I. RY10–RY14 Management Report | 1 |
| Management Area | 1 |
| Summary of Status, Trend, Management Activities, and History of Moose in Unit 15 | 3 |
| Management Direction | 5 |
| Existing Wildlife Management Plans | 5 |
| Codified Objectives | 6 |
| Amounts Reasonably Necessary for Subsistence Harvest | . 6 |
| Intensive Management (IM) | . 6 |
| Management Objectives | 6 |
| Management Activities | . 8 |
| 1. Population Status and Trend | . 8 |
| 2. Mortality–Harvest Monitoring and Regulations | 13 |
| 3. Habitat Assessment–Enhancement | 21 |
| Nonregulatory Management Problems or Needs | 24 |
| Data Recording and Archiving | 24 |
| Agreements | 24 |
| Permitting | 24 |
| | |
| Conclusions and Management Recommendations | 24 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan | 24 26 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan Review of Management Direction | 24 26 26 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan Review of Management Direction Management Direction | 24 26 26 26 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan Review of Management Direction Management Direction Goals | 24 26 26 26 26 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan Review of Management Direction Management Direction Goals Codified Objectives | 24 26 26 26 26 26 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan Review of Management Direction Management Direction Goals Codified Objectives Amount Reasonably Necessary for Subsistence Uses (ANS) | 24 26 26 26 26 26 26 |
| Conclusions and Management Recommendations | 24 26 26 26 26 26 26 27 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan Review of Management Direction Management Direction Goals Codified Objectives Amount Reasonably Necessary for Subsistence Uses (ANS) Intensive Management (IM) Management Objectives | 24 26 26 26 26 26 26 27 27 |
| Conclusions and Management Recommendations | 24 26 26 26 26 26 26 27 27 27 28 |
| Conclusions and Management Recommendations | 24 26 26 26 26 26 26 27 27 28 28 |
| Conclusions and Management Recommendations | 24 26 26 26 26 26 26 27 27 27 28 28 29 |
| Conclusions and Management Recommendations | 24 26 26 26 26 26 26 27 27 28 28 29 30 |
| Conclusions and Management Recommendations | 24 26 26 26 26 26 26 27 27 28 28 29 30 30 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan Review of Management Direction Management Direction Goals Codified Objectives Amount Reasonably Necessary for Subsistence Uses (ANS) Intensive Management (IM) Management Objectives Review of Management Activities 1. Population Status and Trend 2. Mortality-Harvest Monitoring 3. Habitat Assessment-Enhancement Nonregulatory Management Problems or Needs Data Recording and Archiving | 24 26 26 26 26 26 26 27 27 28 28 29 30 30 31 |
| Conclusions and Management Recommendations II. Project Review and RY15–RY19 Plan | 24 26 26 26 26 26 26 27 27 28 28 29 30 30 31 31 |
| Conclusions and Management Recommendations | 24 26 26 26 26 26 26 27 27 28 29 30 30 31 31 31 |

List of Figures

| Figure 1. Map of Unit 15, Alaska boundaries, with indicators of controlled use areas (numbered | |
|--|---|
| circles) as found in the Alaska Hunting Regulations, administrative subunits, and federal | |
| lands | 2 |

List of Tables

| Table 1. Unit 15, Alaska aerial composition counts for moose and estimated population size, regulatory years ^a (RY) 2010–2014. Composition count surveys are conducted separately from Population estimate surveys | ι 9 |
|---|--------|
| Table 2. Trend area 30 Unit 15C moose aerial composition counts, regulatory years (RY) 2010–2014. | 0 |
| Table 3. Unit 15, Alaska reported general season moose harvest and accidental death, regulatory years (RY) 2010–2014. | 4 |
| Table 4. Unit 15, Alaska harvest data for drawing permit hunts, regulatory years (RY) 2010– 2014. | 6 |
| Table 5. Unit 15, Alaska residency and success of moose hunters for the general season,regulatory years (RY) 2010–2014.1 | 7 |
| Table 6. Unit 15, Alaska moose general season harvest chronology (percent of harvest), regulatory years (RY) 2010–2014. | 9 |
| Table 7. Unit 15, Alaska general season transport methods for moose hunters (percent of harvest), regulatory years (RY) 2010–2014. 2010–2014. | 0 |

Purpose of this Report

This report provides a record of survey and inventory management activities for moose in Unit 15 for the 5 regulatory years 2010–2014 and plans for survey and inventory management activities for regulatory years 2015–2019. A regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011). This report is produced primarily to provide agency staff with data and analysis to help guide and record its own efforts but is also provided to the public to inform it of wildlife management activities. In 2016 the Alaska Department of Fish and Game's (ADF&G) Division of Wildlife Conservation launched this type of report to more efficiently report on trends and describe potential changes in data collection activities. It replaces the moose management report of survey and inventory activities that was previously produced every 2 years.

I. RY10–RY14 Management Report

Management Area

Unit 15 incorporates the western portion of the Kenai Peninsula and is broken up into 3 administrative subunits Unit 15A (1,314 mi²), Unit 15B (1,121 mi²), and Unit 15C (2,441 mi²). Each subunit is significantly different in its topography, flora, and ecological history. 15A is the most northern unit and is separated from 15B by the Kenai River and Skilak Lake. 15C is the most southerly unit and is separated from 15B by the Tustumena Glacier, Tustumena Lake, and the Kasilof River (Fig. 1).

15A is relatively flat with many small lakes leading up to the foothills of the Kenai Mountains in the east. The dominant flora is a mixed spruce/hardwood climax community. The Kenai National Wildlife Refuge (KNWR) is the largest landholder in 15A and actively participates in a variety of cooperative moose management programs, including the Alaska Department of Fish and Game Moose Research Center near Sterling and cooperative management of Skilak Loop as a wildlife viewing area. No significant habitat disturbance has occurred in 15A since a 1969 wildfire that encompassed approximately 85,306 acres.

The KNWR is also the largest landholder in 15B. The western portion of 15B is similar to 15A in topography and flora. As you go east, however, 15B becomes more mountainous and transitions into an alpine ecosystem. Forests within 15B succumbed to widespread spruce bark beetle (*Dendroctonus rufipennis*) infestations that began in the 1990s. Unlike 15A, 15B recently experienced significant habitat turnover in the form of large wildfires. The 2014 Funny River Fire burned approximately 196,610 acres, most of it in 15B. This fire burned in a mosaic pattern and should provide good moose habitat in the near future. Two other fires had previously burned within a portion of the Funny River Fire perimeter; the Shanta Creek Fire in 2009 burned approximately 13,212 acres and the King County Fire (2005) burned an additional 10,135 acres. The Funny River Fire completely encompassed the area of the Shanta Creek Fire and a portion of the area of the King County Fire

15C is significantly different from both 15A and 15B. Refuge lands make up only a small portion of the unit, in the northeast corner and a section south of Kachemak Bay. The rest of 15C



Figure 1. Map of Unit 15, Alaska boundaries, with indicators of controlled use areas (numbered circles) as found in the Alaska Hunting Regulations, administrative subunits, and federal lands.

contains a mix of state, private, and municipal land ownership. The portion of 15C north of Kachemak Bay and the Fox River peaks in the Caribou Hills and the Ninilchik Domes and slopes from there down to the lowlands. Very few small lakes are present but numerous riparian areas drain from the highlands. Dominant vegetation is a mosaic consisting of spruce, willow, *Calamagrostis canadensis* (particularly in salvage logged areas), alder, and some hardwood stands. The northern portion of 15C has seen fairly consistent habitat disturbance over the past 2 decades in the form of wildfires, beetle kill, logging, and human development. The portion of 15C south of Kachemak Bay and the Fox River consists of a very different ecotype compared to the northern portion of 15C in the form of a hypermaritime forest (Nowacki et al. 2001), subalpine, and alpine habitats.

Summary of Status, Trend, Management Activities, and History of Moose in Unit 15

Historical records and reports from residents indicate moose became abundant in 15A following a 1947 wildfire. Increased forage following the approximately 280,000-acre fire is the major factor to which high moose densities can be attributed. Point population estimates using the Quadrat survey technique (Evans et al. 1966) for moose fluctuated between 4,436 and 3,197 from 1964 to 1974 (U.S Fish and Wildlife Service 1996). Although seasons were long and either–sex harvest was allowed, the moose population increased beyond its carrying capacity and extensive overbrowsing occurred. A wildfire in 1969 initially reduced moose habitat, affecting approximately 85,306 acres, and harsh winters from 1971 to 1974 reduced the moose population over the entire Kenai Peninsula. Between 1974 and 1979 point estimates for moose showed a decline. By 1982, however, the 1969 burn had produced significant moose habitat and the Gasaway point estimate (Gasaway et al. 1986) for moose had recovered to 4,352 (U.S Fish and Wildlife Service 1996).

A selective harvest strategy with a spike–fork 50–inch bag limit was initiated on the Kenai Peninsula in 1987; this strategy was applied to general season areas in all of Unit 15. The proportion of males in the population subsequently increased, and hunters seemed generally satisfied with the selective harvest strategy. A 5–year evaluation of selective harvest on the Kenai was completed in 1992 (Schwartz et. al., 1992), with a 10–year follow–up in 1999 (The Spike-Fork/50 Task Force. 2000).

The Board of Game identified Unit 15A as an intensive management (IM) area in 1999. This area however, was below objectives for both harvest and population levels upon establishment and has remained below objectives. The established objectives are not attainable without unit wide habitat turnover. Unfortunately, no significant habitat turnover has occurred in 15A since the 1969 burn due to current land management policies, and population estimates since then have shown a significant decline in the number of moose. In 2013, the GSPE population estimate was 1,569 (95% confidence interval \pm 274) and general season harvest remained well below harvest objectives. As a token effort to increase harvest levels, the Board of Game instituted wolf control in a small portion of 15A (49 mi² later expanded to 63 mi²) through ground trapping and permitted aerial gunning. This effort was not biologically justified as the limiting factor in this population is habitat not predators and the area in which control efforts could be conducted was too small to be effective.

Like 15A, moose numbers in 15B were relatively high following the 1947 burn and the good moose habitat it created. Point estimates using the Quadrat survey technique from 1964 to 1971 ranged from 2,307 to 3,314 moose. By the mid-1970s, however, estimates for moose had dropped significantly and by 1982 the point estimate for moose had leveled off at about 1,000 animals (U.S Fish and Wildlife Service 1996). Estimates hovered near 1,000 animals up through the last census conducted in 2001. No population estimate has been produced since 2001 due to lack of funding and poor survey conditions. Composition counts in 15B West suggest a decline from 1994 to 2009. Because these counts were not censuses, it is difficult to determine the extent of the decline, but the total number of moose observed in 2009 composition counts was less than half of those observed in 1994.

Forests within 15B succumbed to widespread spruce bark beetle infestations that began in the 1990s. More than 500,000 hectares of spruce forests were affected (Kenai Peninsula Borough n.d.). Since 2001, infestation rates have decreased as the number of unaffected trees became scarce (Wittwer, compiler 2003). Salvage logging efforts were limited in 15B because most of the area is within the Kenai National Wildlife Refuge, which limits many motorized and mechanical activities.

From 2003 through 2013 several small wildfires burned about 33,949 acres in Unit 15B. Then in 2014, the Funny River Fire burned approximately 5 times the area consumed in the previous decade. The quality of moose habitat in 15B is likely to dramatically increase as a result of this fire.

Available habitat in 15C can be limiting in winters with heavy snow accumulations. Important winter habitat includes the drainages of the Ninilchik River, Stariski Creek, Anchor River, Fritz Creek, the lower reaches of Fox River and Sheep Creek, and the Homer Bench. Despite several winters of deep snow in the late 1990s, the point estimate for moose increased by about 30% between surveys in 1993 and 2002; however, different survey techniques were used, and statistical rigor was lacking in both surveys, so it is difficult to say that an actual increase occurred. The March 2010 census numbers do support that a population increase occurred since the early 1990s.

Widespread spruce bark beetle infestations have also affected this region of the Peninsula. Portions of beetle kill spruce stands outside of designated wilderness have been salvage logged. Spruce mortality and salvage logging efforts have significantly altered moose habitat in this area. Moose browse species did regenerate in logged areas that were scarified after tree removal, but in areas that were not scarified, *Calamagrostis canadensis*, which has poor nutritional value for moose, became the dominant ground cover. Moose browse species are just now beginning to develop in some areas were *Calamagrostis canadensis* is dominant. Some logged areas were replanted with conifers rather than species beneficial for moose browse such as birch. Logged areas could have produced more high-quality moose browse if specific treatments were applied during the salvage operations.

Unit 15C has potential for good moose habitat in the future as browse recovers in burns. Since 2004, wildfires have burned over 87,000 acres in this unit. We have not evaluated the quality of moose habitat regenerated from these fires. The major concerns for moose management in this

unit are maintaining an adequate bull:cow ratio while trying to meet IM objectives and continuing habitat turnover while reducing habitat loss.

A few special areas and seasons exist within Unit15. Harvest is by permit only in the Skilak Loop Management Area in 15A. No permits have been issued in recent years due to population levels. An early bow season currently opens 8 days prior to the general season in units 15A and 15B. 15B East, which is designated as a "trophy" area, is currently open by drawing permit only. During this reporting period the quality (antler size) and quantity of moose harvested within 15B East continued to remain low as did hunter satisfaction. A long established antlerless (cow) hunt persists in Unit 15C. It is intended to limit the number of animals wintering on the Homer Bench to prevent winter loss, habitat destruction, and human moose conflicts. In 2015, an additional antlerless hunt was established in 15C with the intention of limiting moose numbers near the Sterling Highway and the possibility of moose vehicle collisions in years of heavy snowfall. No permits however, have been issued for this hunt to date. Unit 15C also has the only state designated subsistence moose permit area within Unit 15, which is south of Kachemak Bay and a line running from Point Pogisbshi and the point of land between Rocky and Windy bays.

Federal management of subsistence opportunities within the Kenai National Wildlife Refuge has complicated management in recent years. Federal subsistence hunts are open to qualified subsistence users and have different season dates and bag limits than state regulations. Current regulations include an early hunt that begins before the state season, a late hunt that opens after the current state season, and a cow hunt. Bag limits are less restrictive, requiring a lower brow tine limit of 3 or more tines on either and the ability to harvest bulls with a forked antler on at least one side.

Management Direction

EXISTING WILDLIFE MANAGEMENT PLANS

The 1976 Alaska wildlife management plan (Alaska Dept. of Fish & Game 1976) contained 5 sections that applied to moose management within Unit 15 including the Kachemak Bay, Kenai Peninsula, Tustumena, Skilak, and the Kenai Moose Research Center management plans. The primary goal of the Kachemak Bay and Kenai Peninsula plans was to provide the greatest opportunity to participate in moose hunting. The Tustumena plan focused on providing an opportunity to take large-antlered moose; while the Skilak plan was setup to provide viewing opportunities. The Kenai Moose Research Center Plan established the goals of conducting scientific and educational study of moose. While no specific management plan exists today for Unit 15, little has changed in the management direction of the areas specified above since the establishment of the 1976 plan. Periodic changes to management objectives and harvest management strategies based on public comment, staff recommendations, and Board of Game actions have been reported in the division's previous species management reports. The plan portion of this report contains the current management strategy for moose in Unit 15.

Goals

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide the greatest sustained yield opportunity to participate in hunting moose.
- Provide an opportunity for nonconsumptive uses (e g. to view and photograph moose).

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Harvest

The current state subsistence law was passed by the legislature in 1992, which provides a preference for the subsistence uses of all Alaskans regardless of where they reside in the state and prohibits the Board of Game from permitting subsistence hunting in areas identified by the board as nonsubsistence areas. Current subsistence harvest opportunities in Unit 15 as identified under 5AAC 99.025(8) are as follows:

- Units 15A and 15B have a negative customary and traditional use finding for moose.
- Unit 15C has a positive customary and traditional use finding of 5–6 moose in the portion southwest of a line from Point Pogibshi to the point of land between Rocky Bay and Windy Bay.

Intensive Management (IM)

The Intensive Management Law was passed by the Alaska Legislature in 1994. In 1999 the Board of Game adopted a positive finding for intensive management of moose in Units 15A and 15C under 5 AAC 92.108. Current intensive management objectives are as follows:

- Unit 15A
 - Population objective: 3,000–3,500 moose.
 - Harvest objective: 180–350 moose.
- Unit 15C
 - Population objective: 2,500–3,500 moose.
 - Harvest objective: 200–350 moose.

MANAGEMENT OBJECTIVES

- Maintain moose populations at a level to promote public safety through directed harvest.
- Participate in land management decisions that affect moose movements in an effort to direct moose into areas with lower vehicle traffic.

Unit 15A

Maintain a healthy population of moose with a post-hunting bull-to-cow ratio of at least 20–25:100 in Unit 15A, except for the Skilak Loop Wildlife Management Area (SLWMA, Figure 1. #1).

Primary moose management objectives in the SLWMA are as follows:

- Provide opportunities to view moose in a natural setting throughout the year.
- Provide opportunities to view all components of the moose community, including their behavior and habitat.
- Provide opportunities to harvest moose when a reduction in numbers is desirable to achieve other objectives.
- Achieve and maintain the resident population at 130 animals or a density of 1.8 to 2.0 moose per mi². Resident moose in excess of 130 will be available for harvest.
- Maintain a bull-to-cow ratio of at least 40 bulls:100 cows.

In addition to the resident population, moose from surrounding areas commonly winter in SLWMA. Winter populations can easily reach 300 animals when overall moose numbers are high. Habitat will be managed to provide for 130 resident and up to 170 additional wintering moose.

Unit 15B–West

- Maintain a bull-to-cow ratio of 20–25:100.
- Allow for maximum opportunity to participate in hunting in 15B West.

Unit 15B–East

- Maintain a bull-to-cow ratio of 40:100.
- Provide opportunities to harvest large–antlered bulls under aesthetically pleasing conditions.

Unit 15C

- Maintain a bull-to-cow ratio of 20–25:100.
- Maintain a healthy and productive population.

MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Conduct annual composition counts in late November or early December in survey areas 2, 5, 8, 9, 10, and 13 in 15A; in survey areas 903–907, and 15–17 for 15B; and in areas 20, 21, 24, and 26 for 15C.

Data Needs

Information on moose population health and status is needed to direct management action on a yearly basis. Composition counts provide a reliable metric that, with ideal weather conditions and snow cover, can be achieved yearly to provide trend data for comparisons.

Methods

Composition counts are conducted annually from a PA18 or equivalent aircraft if conditions allow in specific trend areas in all subunits. Trend areas for each subunit include 2, 5, 8, 9, 10, and 13 for 15A; 903, 904, 905, 906, 907, 15,16, and 17 for 15B (15B count area boundaries are currently being adjusted); and 20, 21, 24, and 26 for 15C. Each trend area is flown for optimal coverage and all moose sighted are categorized as cow, calf, or bull. Bulls are further classified by antler size into the categories spike-fork, greater than spike-fork, less than 50 inches, or greater than or equal to 50 inches. From these counts we calculate the following metrics: bull-to-cow ratio, calf-to-cow ratio, percent calves, total moose, and moose per hour flown. The actual number of moose seen during composition counts is not directly comparable from year to year, because survey intensity and conditions are inconsistent. However, large scale trends are generally thought to be comparable between years. Composition counts are performed in order to achieve an adequate sample of moose to calculate ratios of bulls to cows and calves to cows.

Results and Discussion

Unit 15A

The bull:cow ratio has fluctuated between 20–36 bulls:100 cows in recent years, always remaining in or above our management objective of 20–25 bulls:100 cows. Calf numbers have also shown very little change over this reporting period with the exception of a slight increase in 2011. No surveys were conducted in the fall of 2014 due to poor snow coverage.

Unit 15B

Composition surveys were flown in 2 areas in fall of 2010 (Table 1, count areas 906-907). Comparing these data to that obtained in 1994 (the last time period these areas were surveyed in the fall) suggests there were more than twice the number of moose in 1994 (N = 214, count areas 906 and 907) compared to counts in 2010 (N = 65, count areas 906 and 907) under similar conditions and flying similar coverage. Because these were composition surveys they indicate only a possible trend. Bull:cow ratios decreased from 49 bulls:100 cows in 1994 to 33 bulls:100 cows in 2010. Indications are that the moose population has declined in Unit 15B. No composition surveys were conducted in fall 2014 due to poor snow coverage.

| | | | | | | | Estimated |
|-------|------|--------------|----------|--------|--------|-------------|--------------------------|
| | | Bulls: | Calves: | % | | Total moose | population |
| Unit | RY | 100 cows | 100 cows | Calves | Adults | observed | size |
| SLWMA | 2010 | 19 | 13 | 10 | 38 | 42 | n/a |
| | 2011 | 38 | 15 | 10 | 72 | 80 | n/a |
| | 2012 | 41 | 17 | 11 | 41 | 46 | n/a |
| | 2013 | 33 | 22 | 14 | 36 | 42 | n/a |
| | 2014 | No surveys c | onducted | | | | n/a |
| 15A | 2010 | 20 | 23 | 16 | 288 | 345 | No survey |
| | 2011 | 36 | 29 | 17 | 402 | 487 | No survey |
| | 2012 | 30 | 25 | 16 | 312 | 372 | 1,269–1,843 ^b |
| | 2013 | 29 | 25 | 16 | 278 | 332 | No survey |
| | 2014 | No surveys c | onducted | | | | |
| 15B | 2010 | 33 | 9 | 6 | 61 | 65 | No survey |
| | 2011 | No surveys c | onducted | | | | |
| | 2012 | No surveys c | onducted | | | | |
| | 2013 | No surveys c | onducted | | | | |
| | 2014 | No surveys c | onducted | | | | |
| 15C | 2010 | 9 | 19 | 15 | 625 | 735 | 2,642-3,196 ^b |
| | 2011 | 14 | 26 | 19 | 877 | 1,077 | No survey |
| | 2012 | 22 | 15 | 11 | 580 | 650 | 2,554–3,855 ^b |
| | 2013 | 19 | 26 | 18 | 966 | 1,177 | No survey |
| | 2014 | 26 | 31 | 20 | 721 | 897 | No survey |

Table 1. Unit 15, Alaska aerial composition counts for moose and estimated population size, regulatory years^a (RY) 2010–2014. Composition count surveys are conducted separately from Population estimate surveys.

^a A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010=1 July 2010–30 June 2011. ^b Estimates from geostatistical census method, estimated population size shown = 95% CI.

Unit15C

In 2010, composition count areas were standardized to provide a more representative sample of Unit 15C moose. Composition counts are now flown in composition count areas 20, 21, 24, and 26 when snow conditions allow. During the 2010 composition counts 9 bulls:100 cows were observed, which was well below the minimum management objective at that time of 15:100 (Table 1). Management actions restricting the bull harvest to 50–inch or 4 brow tine moose for all of Unit 15were taken to address the low bull numbers. This action increased the bull:cow ratio to 22 bulls:100 cows by 2012 and to 26 bulls:100 cows in 2014 (Table 1). In 2013, spike bulls were added back into the harvest. Bull numbers in 15C have continued to increase since 2013. Future regulation changes will have direct effects on overall bull numbers and whether populations stay within management objectives.

Recommendations for Activity 1.1.

Continue composition surveys in current trend count areas in Units 15A and 15C and adjust the composition survey areas in Unit 15B to better represent the unit population.

ACTIVITY 1.2. Conduct composition counts in trend area 30 for Unit 15C every 2 years.

Data Needs

Information on moose population health and status is needed to inform management actions for TM549, the Tier II subsistence moose hunt on the south side of Kachemak Bay. This management area is not conducive to a population estimate using current methods due to dense canopy cover. Composition counts provide a reliable metric that normally can be achieved on a semiannual basis to provide trend data for comparisons.

Methods

Composition counts are conducted biannually from a PA18 Super Cub or equivalent aircraft if conditions allow in trend area 30 in Unit 15C. Major drainages are flown for complete coverage and all moose sighted are categorized as cow, calf, or bull. Bulls are further classified by antler size into the categories spike-fork, greater than spike/fork, less than 50 inches, and greater than or equal to 50 inches. From these counts we calculate the following metrics bull-to-cow ratio, calves-to-cows ratio, percent calves, total moose, and moose per hour flown.

Results and Discussion

The last composition counts for trend area 30 were flown in spring 2011. Only 10 moose were observed of which 2 were calves (Table 2). No surveys have been conducted since 2011 due to budget, personnel, and lack of complete snow cover.

| Calves: Total moose |
|---|
| |
| RY Bulls:100 cows 100 cows % Calves Adults observed |
| 2010 NA NA 20 8 10 |
| 2011 No surveys conducted |
| 2012 No surveys conducted |
| 2013 No surveys conducted |
| 2014 No surveys conducted |

Table 2. Trend area 30 Unit 15C moose aerial composition counts, regulatory years^a (RY)2010–2014.

^a A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.

Recommendations for Activity 1.2.

Continue composition counts of major drainages on a triannual basis.

ACTIVITY 1.3. Conduct a census to estimate population levels once every 3 years.

Data Needs

Moose abundance is used to estimate sustainable harvest and provides a density context for interpreting nutritional condition relative to habitat conditions. Lack of consistent snow across units usually precludes census work in early winter but conditions commonly develop soon enough to complete composition surveys in critical areas. Abundance surveys can then be flown in late winter in game management units that hold enough snow.

Methods

Geospatial population estimator (GSPE; Kellie and Delong 2006) surveys with an estimate of sightability correction are conducted when feasible during February and March in all units. This procedure produces population estimates and statistically bounded sex and age composition estimates by using fixed or random sampling designs and geostatistical models of autocorrelation. It is designed for high search intensity (8–12 min/mi²) from a PA18 or equivalent aircraft to obtain a relatively unbiased estimate of moose numbers. If lower intensity is achieved it is accounted for in the sightability correction factor. Validation of stratification classification of both high and low strata units through visual observation during surveys is necessary to ensure areas have not been misclassified. Presurvey biometric consultation should be employed to improve statistical validity for each survey.

The last survey in 2013 for Unit 15A used 41 high and 24 low strata units out of a total of 207 survey units of which 79 where stratified as high and 128 as low. For Unit 15C 45 of 74 high and 26 of 122 low strata units were sampled. No recent surveys have been conducted in 15B, but in 2014 in preparation for a census, biometrician expertise was sought to develop an optimum sampling strategy.

Results and Discussion

Unit 15A

The Unit 15A moose population is currently below its IM population size objective. The most recent population survey produced in 2013 provided a point estimate of 1,569 (95% CI: 1,296–1,843, SCF 1.27, Table 1), well below the IM objective of 3,000–3,500. The most recent survey peak in 1991 provided a point estimate of 3,432 (95% CI: 2,921–3,943, SCF 1.21), but all surveys since then have been outside the IM objectives as well (2001: 1,942 (95% CI: 1,555–2,329, assumed SCF 1.25), 2008: 1,670 (95% CI: 1,405–1,934, assumed SCF 1.25)). Moose numbers in the SLWMA within 15A are at an all-time low and well below the 130 animal objective required for permits to be issued (Table 1).

Unit 15B

No census work has been conducted since 2001 in 15B. However, as indicated above, data from fall composition surveys suggest a population decline in this unit. Census surveys have not been conducted in recent years due to a lack of suitable survey conditions. The February 2001 census of the 650.4 square miles of suitable moose habitat in Unit 15B estimated the population at 958 moose (95% CI: 777–1,139) and a density of about 1.5 moose/mi². Because the census was

conducted during February, after most bulls had shed their antlers, composition by sex was not determined. Calves composed 21% of the population, compared to 10% found in the February 1990 census. As indicated above, data from fall composition surveys suggest a population decline in this management unit. Conducting a population survey in 15B should be a high priority when suitable survey conditions exist; particularly since the 2014 Funny River Fire burned a substantial portion of this unit, and we are likely to see significant changes in population levels in coming years. Future harvest regulations, next to be addressed during the 2019 Board of Game cycle, need to reflect probable changes in population levels.

Unit 15C

The 15C moose population is currently within the intensive management objective of 2,500– 3.500 moose. The most recent geospatial censuses (Ver Hoef 2001) was conducted in February 2013 and produced a population estimate of 3,204 (95% CI: 2,554–3,855, SCF 1.3) (Table 1). This is an increase from the point estimate produced in 2010 of 2,919 moose (95% CI: 2,642– 3,196, assumed SCF1.33). Both estimates are lower than that derived from a geospatial census conducted in the winter of 2001–2002 of 3,965 (95% CI: 3,638–4,585); however, that survey was not conducted using currently accepted sampling protocols and was likely biased high. The 2013 and 2010 estimate are also higher than the random–stratified census (Gasaway et al. 1986) conducted in lowland portions of Unit 15C north of Kachemak Bay (1,190 mi²) during the winter of 1992–1993 of 2,079 moose (95% CI: 1,425–2,734, SCF 1.49). When taken together these population estimates suggest that the 15C moose population is increasing and within IM objectives.

Recommendations for Activity 1.3.

Continue producing population estimates for Units 15A, 15B, and 15C using survey census methods as needed.

ACTIVITY 1.4. Research the productivity, survival, and condition of cow and calf moose in Units 15A and 15C.

Data Needs

Baseline data on productivity of adult cows, annual survival of adult cows and their calves, and general health and nutritional measures can be used to assess the status of the moose population given its current density and habitat availability and quality.

Methods

Division research projects are underway to identify factors affecting calf production and survival and survival of adult moose in Units 15A and 15C (Principle investigator Thomas McDonough, Identification of factors affecting reproduction and survival of moose on the northwestern Kenai Peninsula (Game Management Unit 15A) and Identification of factors affecting reproduction and survival of moose on the southern Kenai Peninsula (Game Management Unit 15A) and Identification of factors affecting reproduction and survival of moose on the southern Kenai Peninsula (Game Management Unit 15C), and Principle Investigator Dan Thompson, Evaluating the physiological and behavioral responses of moose (*Alces alces*) to fluctuating environment temperatures).

These projects maintain a sample of about 50 radiocollared cows in both Units 15A and 15C. During captures, cows are assessed for overall body fat through ultrasound measures of rump fat. Lean mass condition is assessed using the Franzmann Index. These assessments are done in both the fall when animals should be at their peak condition and in the spring as they approach their low point of body reserves. Pregnancy, disease, and trace mineral nutrition is assessed through blood sampling. Aerial monitoring of collared animals is conducted throughout the year to assess survival and intensive aerial tracking during parturition is used to determine parturition date, twinning, and early calf survival.

Results and Discussion

Results from this work are currently in various stages of publication. Brief report summaries for some of this work can be found on the department website at:

http://www.adfg.alaska.gov/index.cfm?adfg=librarypublications.publications_reports#wildlife

Recommendations for Activity 1.4.

Continue collaring and monitoring animals for reproductive and health metrics.

2. Mortality-Harvest Monitoring and Regulations

ACTIVITY 2.1. Monitor harvest and mortality in Unit 15 by regulatory year.

Data Needs

Units 15A and 15C were identified by the Board of Game (BOG) for IM of moose with harvest objectives of 180–350 and 200–350, respectively. The BOG set the Amount Necessary for Subsistence (ANS) in the area southwest of the line from Point Pogibshi to the point of land between Rocky Bay and Windy Bay at 5–6 moose annually. Annual harvest summaries are needed to establish quotas to ensure we remain within sustained yield in all units. Monitoring and documentation of roadkill and illegal take will also help to ensure that harvest is maintained within sustained yield limits.

Methods

Harvest is monitored through mandatory sealing of antlers, reports from harvest tickets, and permit reports that are recorded in WinfoNet, the central ADF&G wildlife harvest database. Documentation of roadkills comes from trooper dispatch reports and illegal harvest is documented from sealing reports, trooper reports, and other incidental findings. Roadkill and illegal harvest data are maintained at the local level on the Homer office network drive: Homer Shared (O:)DWC/ADF&G–Homer Files/Species Data/Moose.

Season and Bag Limit

The general season for Unit 15A and 15B has been 10–17 August (archery only), and 20 August–20 September since 1999. Unit 15C shares the 20 August–20 September dates but does not have an archery season. From 1987 to 2010, the bag limit was 1 bull with a spike or fork on at least 1 antler, or 50–inch antlers, or antlers with 3 or more brow tines on at least 1 side (SF-50-3). Harvest statistics are shown in Tables 3 and 4. In 2011, the bag limit was restricted to 1 bull

with 50–inch antlers or antlers with 4 or more brow tines on at least 1 side (SF-50-4) and hunting was closed to nonresidents in Units 15A and 15C. Spike bulls were returned to the legal harvest in 2013. Current Unit 15 moose season dates and bag limits are available online at:

http://www.adfg.alaska.gov/index.cfm?adfg=wildliferegulations.hunting.

During its 2006 meeting the Federal Subsistence Board liberalized the moose hunting season in Units 15B and 15C for federally qualified subsistence users on federal lands. These users gained additional time at the beginning and end of the hunting season with a start date of Aug. 10 for all methods and a second season from 20 October–10 November after the traditional state season dates. Subsistence users did not experience the restriction in the bag limit that users hunting under state regulations did from 2011–2014. The bag limit remained SF-50-3. Additionally, the Federal Subsistence board added a cow hunt in 2014 for Unit 15C with season dates of 10 Aug–20 Sep. Current regulations and information on qualified users can be found at:

http://www.doi.gov/subsistence/index.cfm

| | | | | | | | | | | Total |
|------|------|------|----------|-----------|-------|---|------|----------|-------|-----------|
| | | Rep | orted hu | inter har | vest | | Acc | reported | | |
| Unit | RY | Bull | Cow | Unk | Total | F | Road | Other | Total | mortality |
| 15A | 2010 | 117 | 0 | 2 | 119 | | 137 | 0 | 137 | 256 |
| | 2011 | 4 | 0 | 0 | 4 | | 103 | 0 | 103 | 107 |
| | 2012 | 7 | 0 | 0 | 7 | | 84 | 0 | 84 | 91 |
| | 2013 | 35 | 0 | 1 | 36 | | 93 | 0 | 93 | 129 |
| | 2014 | 49 | 0 | 1 | 50 | | 61 | 0 | 61 | 111 |
| 15B | 2010 | 51 | 0 | 1 | 52 | | 65 | 0 | 65 | 117 |
| | 2011 | 7 | 0 | 0 | 7 | | 49 | 0 | 49 | 56 |
| | 2012 | 6 | 0 | 0 | 6 | | 41 | 0 | 41 | 47 |
| | 2013 | 24 | 0 | 0 | 24 | | 42 | 0 | 42 | 66 |
| | 2014 | 23 | 0 | 2 | 25 | | 34 | 0 | 34 | 59 |
| 15C | 2010 | 214 | 3 | 3 | 220 | | 46 | 0 | 46 | 266 |
| | 2011 | 25 | 0 | 1 | 26 | | 53 | 0 | 53 | 79 |
| | 2012 | 24 | 0 | 3 | 27 | | 52 | 0 | 52 | 79 |
| | 2013 | 96 | 0 | 2 | 98 | | 56 | 0 | 56 | 154 |
| | 2014 | 145 | 0 | 1 | 146 | | 63 | 0 | 63 | 209 |

Table 3. Unit 15, Alaska reported general season moose harvest and accidental death, regulatory years^a (RY) 2010–2014.

^a A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010=1 July 2010-30 June 2011.

Results and Discussion

Harvest by Hunters

Moose harvest has declined significantly across Unit 15 in recent years. During this reporting period we have averaged a yearly general season harvest of 169 animals for Unit 15 compared to the previous 5 year (RY05–RY09) annual general season harvest of 387 animals. Unit 15A and 15C harvests are currently below IM harvest objectives (Table 3 and 4). Unit 15A is below harvest objectives due to low population numbers that make objectives unreasonable to attain. Unit 15C is below harvest objectives due to restrictive regulations implemented in order to recover bull:cow ratios to acceptable levels. A previous overharvest objectives in 15C could be met in the future with an increased bull harvest, if bull numbers in the population continue to increase under the current restrictive harvest regulations, and additional antlerless harvest. Since bull ratios are above management objectives, new regulations can be set to limit the chance of future overharvest but still allow additional harvest opportunity to meet IM objectives. Regulation changes should be considered and addressed during the 2019 board cycle.

Unit 15B harvest has been severely limited in recent years due to low moose numbers and hunter participation in permit hunts. With recent habitat changes in Unit 15B and likely changes in moose numbers, harvest regulation changes should be considered and addressed during the 2019 board cycle.

Permit Hunts

Unit 15A. No permits were issued for the SLWMA during this report period.

Unit 15B. 15B East is managed as an area where hunters are able to harvest large–antlered bulls through a drawing permit system. The hunt is split by regulation into an early and late season. Since 2009, no permits have been issued for the late season due to low harvest levels, hunter complaints, and population concerns. Permittees reported harvesting an average of 3 bulls per year during the reporting period (Table 4). The management direction of this hunt should be reevaluated in preparation for the 2019 Board of Game meeting.

Unit 15C. Since 1987 there has been a Tier II subsistence hunt (TM549) for any bull in a portion of Unit 15C southwest of a line from Point Pogibshi to the point of land between Rocky and Windy bays. An average of 2 bulls have been taken annually during this season in the last 5 years (Table 4). The antlerless hunt for moose near Homer was initiated in 1995 (DM549). During RY10–RY14, 50 permits were issued each year which produced an average annual harvest of 20 moose (Table 4).

| | | | Permits | Permittees | Percent | Harvest | | | |
|------|-----------|------|---------|-------------|---------|---------|------|-----|-------|
| Unit | Hunt No. | RY | Issued | that hunted | success | Bulls | Cows | Unk | Total |
| 15B | DM530-539 | 2010 | 50 | 19 | 16 | 3 | 0 | 0 | 3 |
| | (combined | 2011 | 50 | 22 | 14 | 3 | 0 | 0 | 3 |
| | totals) | 2012 | 50 | 18 | 28 | 5 | 0 | 0 | 5 |
| | | 2013 | 50 | 23 | 13 | 3 | 0 | 0 | 3 |
| | | 2014 | 50 | 21 | 0 | 0 | 0 | 0 | 0 |
| 15C | DM549 | 2010 | 50 | 43 | 44 | 0 | 19 | 0 | 19 |
| | | 2011 | 50 | 42 | 69 | 0 | 29 | 0 | 29 |
| | | 2012 | 50 | 42 | 45 | 0 | 19 | 0 | 19 |
| | | 2013 | 50 | 41 | 42 | 0 | 17 | 0 | 17 |
| | | 2014 | 50 | 35 | 51 | 0 | 18 | 0 | 18 |
| | TM549 | 2010 | 4 | 4 | 25 | 1 | 0 | 0 | 1 |
| | | 2011 | 4 | 4 | 75 | 3 | 0 | 0 | 3 |
| | | 2012 | 4 | 4 | 50 | 2 | 0 | 0 | 2 |
| | | 2013 | 4 | 4 | 50 | 2 | 0 | 0 | 2 |
| | | 2014 | 4 | 4 | 50 | 2 | 0 | 0 | 2 |

Table 4. Unit 15, Alaska harvest data for drawing permit hunts, regulatory years^a (RY)2010–2014.

^a A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.

Hunter Residency and Success

Unit 15A. General season hunter success was at 13% in 2010 and then declined dramatically due to increased harvest restrictions in 2011 and 2012 (1% and 2% success, respectively). With relaxation of harvest restrictions in 2013 harvest began to increase (Table 5). During all years, local residents (people living in Unit 15) accounted for the majority (82–100%) of reported successful moose hunters.

Nonlocal residents took a maximum of 11% of harvested moose annually in Unit 15A during this reporting period and nonresident take never surpassed 3%. Starting in 2011, moose hunting was restricted to resident hunters only.

Unit 15B–West. General season hunter success ranged 8–19% during the last 5 years (Table 5). The reduction in success during 2011 and 2012 was most likely due to increased harvest restrictions. During all years, local residents (people living in Unit 15) accounted for the majority (81–100%) of reported successful moose hunters. Neither nonlocal nor nonresident hunters reported harvest surpassing 8% in any given year.

| | | | Suce | cessful | | | Unsuccessful | | | | |
|---------------|------|--------------------|----------|----------|------------------------|--------------------|--------------|----------|---------------|---------|--|
| T T •/ | DV | Local ^b | Nonlocal | Non- | | Local ^b | Nonlocal | Non- | T (10 | Total | |
| Unit | ΚY | resident | resident | resident | Total ^e (%) | resident | resident | resident | Total | hunters | |
| 15A | 2010 | 102 | 13 | 4 | 119 (13) | 657 | 126 | 15 | 800 | 919 | |
| | 2011 | 4 | 0 | 0 | 4 (1) | 229 | 48 | 0 | 286 | 290 | |
| | 2012 | 7 | 0 | 0 | 7 (2) | 260 | 36 | 0 | 297 | 304 | |
| | 2013 | 31 | 4 | 1 | 36 (7) | 444 | 49 | 4 | 498 | 534 | |
| | 2014 | 46 | 2 | 0 | 49 (9) | 456 | 64 | 1 | 523 | 572 | |
| 15B | 2010 | 44 | 4 | 4 | 52 (19) | 192 | 27 | 6 | 225 | 277 | |
| | 2011 | 6 | 1 | 0 | 7 (8) | 64 | 8 | 0 | 77 | 84 | |
| | 2012 | 6 | 0 | 0 | 6 (8) | 64 | 5 | 1 | 70 | 76 | |
| | 2013 | 23 | 1 | 0 | 24 (15) | 122 | 11 | 5 | 138 | 162 | |
| | 2014 | 24 | 1 | 0 | 25 (15) | 130 | 9 | 0 | 139 | 164 | |
| 15C | 2010 | 188 | 24 | 7 | 220 (18) | 849 | 135 | 20 | 1,005 | 1,225 | |
| | 2011 | 23 | 3 | 0 | 26 (6) | 353 | 38 | 1 | 399 | 425 | |
| | 2012 | 26 | 1 | 0 | 27 (6) | 395 | 38 | 0 | 434 | 461 | |
| | 2013 | 88 | 7 | 2 | 98 (12) | 678 | 58 | 2 | 745 | 843 | |
| | 2014 | 130 | 13 | 1 | 144 (15) | 732 | 76 | 3 | 812 | 956 | |

Table 5. Unit 15, Alaska residency and success of moose hunters for the general season, regulatory years^a (RY) 2010–2014.

^a A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011. ^b Local = residents of Unit 15.

^c Includes unspecified residency.

Unit 15C. General season hunter success ranged 6–18% during the last 5 years (Table 5). Lower success rates in 2011 and 2012 (6% each year) were most likely due to increased harvest restrictions. During all years, local residents (people living in Unit 15) accounted for the majority (85–96%) of reported successful moose hunters. Nonlocal residents took a maximum of 12% of reported harvest and nonresidents did not exceed 3% of reported harvest in any given year. In 2011, moose hunting was restricted to resident hunters only.

During this reporting period 25% of the reported general season moose harvest came from Unit 15A, 14% from 15B and 61% from Unit 15C.

Harvest Chronology

The chronology of the harvest depends on weather conditions and other factors unrelated to moose abundance. The highest proportions of the harvest generally occur at the start and the end of the season (Table 6).

Transport Methods

Most moose hunters use highway vehicles as their primary method of transportation to access hunting areas in Units 15A and 15B (Table 7). The most popular method used in Unit 15C is the all-terrain vehicle (ATV).

Other Mortality

We began a public awareness program in 1990 in an effort to reduce the number of vehicle– moose collisions (Del Frate and Spraker 1991). Unfortunately, while collisions declined for a short time, collisions have again increased, likely due to animals seeking forage near roadways as browse species in 15A have continued to mature and become unavailable to moose and as traffic levels have continued to increase.

During the winter of 2012–2013 a concerted effort was made to document the number of animals that died from 'winter kill', deaths not attributed to human causes or predation, after an anecdotal increase was noticed in 2011.Winter kill deaths appear to be increasing in 15A. The number of known moose that died from causes other than predation during the winter of 2012–2013 was twice as high in unit 15A (69) as either Unit 15B (36) or Unit 15C (28). Interestingly, 2012–2013 was a relatively mild winter with moderate snowfall compared to previous winters and the population density of moose from our last census estimates in 2013 was considerably higher in Unit 15C (2.7) than Unit 15A (1.2). The winters of 2013–2014 and 2014–2015 were even more moderate in comparison and winter mortality declined.

Unit 15A. Crippling loss by hunters and loss to predation was unknown. During RY10-RY14, the yearly average of moose killed in 15A by motor vehicles increased to 96 from the previous 5-year average of 83 (Table 3). The majority of moose killed by vehicles are cows and calves. These data only include moose that were hit by vehicles and died at the collision site. The number of moose that were hit, walked off, but later died from injuries sustained during the collision is unknown.

| | | | - | Percent | of harv | est by l | harvest j | period | | . – |
|------|------|-------------------|-------|---------|---------|----------|-----------|--------|---------|---------|
| | | 8/10- | 8/20- | 8/26- | 9/1- | 9/6- | 9/11- | 9/16- | Unknown | |
| Unit | RY | 8/17 ^b | 8/25 | 8/31 | 9/5 | 9/10 | 9/15 | 9/20 | /Other | Harvest |
| 15A | 2010 | 27 | 24 | 8 | 5 | 8 | 11 | 12 | 7 | 119 |
| | 2011 | 25 | 0 | 0 | 0 | 0 | 25 | 50 | 0 | 4 |
| | 2012 | 14 | 14 | 0 | 0 | 0 | 29 | 43 | 0 | 7 |
| | 2013 | 42 | 17 | 3 | 6 | 6 | 6 | 19 | 3 | 36 |
| | 2014 | 22 | 22 | 4 | 8 | 8 | 24 | 8 | 2 | 49 |
| 15B | 2010 | 25 | 25 | 6 | 4 | 4 | 10 | 23 | 4 | 52 |
| | 2011 | 0 | 0 | 0 | 0 | 0 | 0 | 71 | 29 | 7 |
| | 2012 | 17 | 0 | 0 | 0 | 33 | 50 | 0 | 0 | 6 |
| | 2013 | 25 | 17 | 13 | 13 | 13 | 8 | 13 | 0 | 24 |
| | 2014 | 16 | 28 | 12 | 4 | 0 | 12 | 24 | 4 | 25 |
| 15C | 2010 | 2 | 38 | 12 | 7 | 12 | 11 | 13 | 4 | 220 |
| | 2011 | 0 | 4 | 8 | 12 | 4 | 35 | 31 | 8 | 26 |
| | 2012 | 0 | 7 | 7 | 0 | 11 | 22 | 41 | 11 | 27 |
| | 2013 | 1 | 39 | 10 | 6 | 7 | 13 | 19 | 4 | 98 |
| | 2014 | 1 | 26 | 15 | 8 | 16 | 12 | 18 | 4 | 144 |

Table 6. Unit 15, Alaska moose general season harvest chronology (percent of harvest), regulatory years^a (RY) 2010–2014.

^a A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011. ^b Archery–only season is 10–17 August in 15A and 15B only.

| | _ | Percent of harvest by transport method | | | | | | | | |
|------|------|--|----------|------|---------|----------|------------------|----------|---------|--|
| | | 3- or 4- wheel | | | Highway | Horse/ | | Unknown/ | | |
| Unit | RY | ATV ^b | Airplane | Boat | vehicle | dog team | ORV ^b | other | Harvest | |
| 15A | 2010 | 23 | 3 | 6 | 60 | 0 | 6 | 3 | 119 | |
| | 2011 | 0 | 0 | 25 | 75 | 0 | 0 | 0 | 4 | |
| | 2012 | 0 | 0 | 14 | 57 | 14 | 0 | 14 | 7 | |
| | 2013 | 17 | 0 | 6 | 64 | 3 | 3 | 8 | 36 | |
| | 2014 | 18 | 2 | 2 | 63 | 2 | 2 | 10 | 49 | |
| 15B | 2010 | 8 | 0 | 6 | 79 | 0 | 4 | 4 | 52 | |
| | 2011 | 0 | 14 | 29 | 43 | 0 | 14 | 0 | 7 | |
| | 2012 | 0 | 0 | 0 | 67 | 0 | 0 | 33 | 6 | |
| | 2013 | 8 | 0 | 4 | 71 | 0 | 0 | 17 | 24 | |
| | 2014 | 0 | 0 | 0 | 76 | 4 | 0 | 20 | 25 | |
| 15C | 2010 | 48 | 0 | 2 | 34 | 6 | 8 | 2 | 220 | |
| | 2011 | 54 | 0 | 8 | 12 | 23 | 0 | 4 | 26 | |
| | 2012 | 48 | 0 | 0 | 11 | 22 | 4 | 15 | 27 | |
| | 2013 | 44 | 1 | 2 | 32 | 8 | 5 | 8 | 98 | |
| | 2014 | 53 | 0 | 4 | 27 | 7 | 3 | 6 | 144 | |

Table 7. Unit 15, Alaska general season transport methods for moose hunters (percent of harvest), regulatory years^a (RY) 2010–2014.

^a A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011. ^b ATV = all-terrain vehicle; ORV = off-road vehicle (larger than ATV or >4wheel).

Unit 15B. Crippling loss by hunters and loss to predation was unknown. During RY10-RY14, an average of 46 moose per year was killed by motor vehicles in Unit 15B (Table 3).

Unit 15C. Crippling loss by hunters and loss to predation was unknown. During RY10-RY14, an average of 52 moose per year was killed by motor vehicles in Unit 15C (Table 3). The number of moose wintering within the Homer Bench continues to be habitat limited during deep snow winters. The level of mortality for these moose during severe winters is high.

Alaska Board of Game Actions and Emergency Orders

In 2010, the Board of Game (BOG) provided additional hunting opportunity (15–19 October) for TM549 due to poor hunting conditions during the regularly scheduled dates and hardships caused by poor salmon returns.

During the March 2011 meeting, The Board of Game reauthorized the antlerless moose permit hunt for the Homer area (DM549) but did not reauthorize the Skilak Loop (DM524) hunt. Other actions taken at the March 2011 meeting included changing the antler requirements for a legal bull from spike/fork 50/3 to 50/4 only for all general season hunts in Units 7 and 15. The board also eliminated nonresident moose hunting in units 15A and 15C and requested that the Alaska Department of Fish and Game develop an IM proposal that included aerial shooting of wolves in Units 15A and 15C and present the proposal at the November 2011 meeting in Barrow. In March of 2013, the Board of Game directed the department to implement wolf control in Unit 15A. BOG summary information is available on the ADF&G website:

http://www.adfg.alaska.gov/index.cfm?adfg=gameboard.meetinginfo.

Recommendations for Activity 2.1

Continue monitoring harvest through antler sealing and required hunter reports, and document additional human-caused mortality.

<u>3. Habitat Assessment–Enhancement</u>ACTIVITY 3.1.Monitor moose browse production and removal to better understand sustainability of moose density.

Data Needs

Monitoring of forage plants provides information about the proportion of available browse being removed by the existing moose population and the degree of browsing pressure during the life of the plant (Seaton 2002). Browse biomass removal is an index of moose nutritional condition (Seaton 2002, Boertje et al. 2007, Seaton et al. 2011). Monitoring browse plant architecture provides additional information on the effects of moose browsing on vegetation condition as a function of moose density (Seaton 2002, Paragi et al. 2015). Browse data are best used in conjunction with body condition and other animal parameters to assess habitat condition and trend and gauge whether more moose could be sustained on the landscape.

Methods

Forage plant production, architecture, and browse removal is characterized using methods from Seaton (2002).

Results and Discussion

No habitat assessment surveys were completed during the reporting period.

Recommendations for Activity 3.1.

Modify: institute browse surveys in IM Units 15A and 15C.

ACTIVITY 3.2.Conduct habitat enhancement activities to increase moose population numbers in 15A.

Data Needs

Identify treatment areas that would be most beneficial to facilitate future prescribed and wildland fire use for wildlife habitat enhancement and provide protection to communities from wildfires.

Methods

Contractors were hired to clear cut mature aspen and spruce, and plant birch seedlings on 85 acres of private land adjacent to the Kenai National Wildlife Refuge.

Results and Discussion

In March and April 2013, 85 acres of mature mixed hardwoods were mechanically treated through clearcutting and replanting on Kenai Natives Association land north of the Sterling Highway and east of Swanson River Road. This treatment was conducted by Evergreen Alaska Inc. The total cost of the project was \$93,137, funded with an appropriation from the Alaska State Legislature for the 2013 fiscal year.

Additional interagency habitat improvement projects coordinated by ADF&G are planned for coming years in Unit 15A. ADF&G requested and received a long-term funding commitment of \$1 million over the course of 5 years from the legislature to facilitate habitat enhancement statewide, with \$400,000 dedicated to the Kenai Peninsula. This funding is to be directed toward private contractors operating on public lands along with wildland firefighters to support interagency burn operations, both natural and prescribed. Building on the work of the Spruce Beetle Task Force and the associated community outreach, additional fuel breaks are expected to be developed to protect communities and infrastructure and support the use of fire for habitat enhancement. Through partnerships with the Alaska Division of Forestry, the Kenai Peninsula Borough, U.S. Forest Service and the Kenai National Wildlife Refuge, and others, ADF&G hopes to return fire to the landscape for the benefit of wildlife and ecosystem processes; which will also reduce the likelihood of high intensity wildland fires prone to damaging private property and infrastructure.

Through this grant, and additional funds from project partners, the Sterling Fuel Break is being initiated in April 2016. The intention is to remove and thin fuels around the community to protect homes and infrastructure from fire, and to make it possible to allow some fires to burn north of the community where late successional forests could be brought back to an early seral state, supportive of hardwood species serving as moose forage.

ADF&G recently applied for an additional \$2,743,900 in federal aid from the Wildlife Restoration Program (using a funding match from Chugachmiut Native Corporation) specific to the Kenai Peninsula for habitat enhancement. These funds will continue the effort to build fuel breaks so that wildland and prescribed fire may be used in the Kenai National Wildlife Refuge to benefit habitat on a landscape level. An associated moose movement study will be continued for Units 15A and 15B to support identifying best practices for habitat enhancement treatments.

Recommendations for Activity 3.2.

Continue habitat improvement projects that support the use of prescribed fire on the landscape to enhance available moose browse.

ACTIVITY 3.3. Conduct activities to prepare for future habitat enhancement work in Unit 15B.

Data Needs

Identify treatment areas that would be most beneficial to facilitate future prescribed fire efforts and provide protection to communities from wildfires.

Methods

No habitat enhancement activities were planned or completed during the reporting period. The 2014 Funny River fire burned over an area of 195,000 acres in Unit 15B. Kenai National Wildlife Refuge staff are monitoring the vegetative response in selected locations.

Results and Discussion

Nothing to report.

Recommendations for Activity 3.3.

Modify: identify future habitat enhancement projects that would facilitate the use of prescribed fire in 15B.

ACTIVITY 3.4. Conduct habitat enhancement activities for moose population sustainability in Unit 15C.

Data Needs

Identify treatment areas that would be most beneficial to facilitate prescribed fire and wildfire use efforts and provide protection to communities from wildfires.

Methods

Work with Kachemak Moose Habitat Inc. and other local nonprofits to improve moose habitat on the southern Kenai Peninsula using mitigation funds from the construction of the Bradley Lake Hydroelectric Project and other resources.

Results and Discussion

Department staff continued to work with Kachemak Moose Habitat Inc. and other local conservation groups to identify and purchase land parcels for moose habitat protection. Several

new parcels of land were purchased by Kachemak Moose Habitat in recent years including additional parcels around Beluga Lake, the Anchor River, Diamond Ridge, and Stariski Creek.

Recommendations for Activity 3.4.

Modify: identify future habitat enhancement projects that would facilitate the future use of prescribed fire in 15C.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

No nonregulatory management problems or needs have been identified at this time.

Data Recording and Archiving

- GSPE data are stored on an internal database housed on a server (http://winfonet.alaska.gov/index.cfm).
- Field data sheets are stored in filing cabinets in the Homer Assistant Area Biologist's office and scanned and housed on the computer server in the Homer office (O:\DWC\ADF&G-Homer Files\Species Data\Moose\Survey Data

Agreements

No management agreements exist at this time for Unit 15.

Permitting

No management related permits exist at this time for Unit 15.

Conclusions and Management Recommendations

Unit 15A. The 15A moose population is doing poorly. Currently, the largest impacts on the moose population are declining habitat quality and deaths caused by collisions with motor vehicles. The downward trend in Unit 15A moose numbers will likely continue in the absence of significant habitat altering events (such as burns encompassing more than 50,000 acres).

IM objectives for Unit 15A need to be evaluated and adjusted to match our current understanding of moose population and habitat dynamics. This unit has been outside of both harvest and population level IM objectives almost every year since they were established. IM objectives are currently based on the peak moose population that existed following the 1969 burn. Schwartz and Franzmann (1991) stated that by 1989 the moose population in Unit 15A was likely above carrying capacity in the area encompassed by the 1969 burn, and IM population objectives were based on the 1989 population size. In the absence of periodic (every 20–25 years) and significant (50,000 acres or more) wildfire or other habitat events that would improve the availability of moose browse, it is unlikely we can maintain a moose population of 3,000–3,500 moose (the IM population objective) in Unit 15A. Without periodic and significant habitat alteration, a more reasonable expectation would be for Unit 15A to support a moose density of 1–2 moose per square mile on a sustained basis. This equates to a population of about 1,300–2,600 moose.

Direct habitat manipulation is currently unlikely to dramatically improve habitat conditions under current management limitations. Mechanical treatment is costly and only very limited amounts of habitat can be treated by this means. Controlled burning has not been implemented to date, due to resource limitations, burn conditions, and management directives.

Enhancing habitat at a landscape scale will require the use of fire to regenerate tree and shrub species needed to increase the quality and quantity of moose forage such as early seral hardwood species. In addition to creating winter forage for moose, using wildland and prescribed fire reduces the volume of 'fuel' in this expansive forested area.

Through the Kenai Peninsula interagency fuel break working group, ADF&G, Alaska Department of Natural Resources Division of Forestry, U.S. Fish & Wildlife Service, and Chugachmiut are leveraging funds and capacity across land ownerships boundaries to build fuel breaks at the wildland urban interface. ADF&G is contributing funds it receives through the federal Wildlife Restoration Program to support fulfillment of the combined objectives: to protect lives and infrastructure from wildland fire, enhance wildlife habitat, and restore ecosystem functions. Once established, the fuel breaks around Sterling and other north Kenai communities will allow for the use of wildland and prescribed fire in Unit 15A.

As a token effort to increase harvest levels, the Board of Game instituted wolf control in a small portion of 15A (49 mi² later expanded to 63 mi²) through ground trapping and permitted aerial gunning. This effort was not biologically justified as the limiting factor in this population is habitat, and the area in which it could be conducted was too small to be effective. We do not support implementing wolf control under the current habitat conditions, particularly with an inadequate treatment area.

Unit 15B. The 15B moose population is currently believed to be at low numbers. Harvest in 15B West during the general season is low. The number and "quality" of moose taken in the permit hunts in Unit 15B East and complaints from hunters who had difficulty locating and harvesting animals in conjunction with supporting survey results suggested the department needed to take action. Consequently, no permits have been issued for the late season (26 September–15 October) since 2009. Harvest levels in both East and West are within acceptable guidelines to maintain minimum bull:cow ratios.

In May of 2014, the Funny River Fire burned approximately 195,290 acres in Unit 15B. The fire burned in a mosaic pattern leaving some portions of the burn untouched or lightly burned while completely consuming fuels in other areas. This burn will likely provide good moose habitat in 15B in coming years, which may lead to the recovery of moose numbers. With recovery, we should look to provide more harvest opportunity in Unit 15B through avenues such as opening the entire unit to a general season hunt or increasing permit numbers outside of the current seasons.

Unit 15C. The bull:cow ratio in 15C increased with the harvest restrictions put in place during RY11 and RY12 hunting seasons. Numbers recovered enough to reintroduce spike bulls back into the harvest in RY13 and bull numbers continue to increase. Population levels continue to remain high and appear to be slightly increasing. Enough habitat has turned over in recent years to provide for a stable population. We must however, be careful not to let moose numbers

increase or we risk over running the habitat. Habitat also needs to continue to turn over in order to maintain current population levels and habitat continues to be steadily lost to development increasing the need to maintain high quality moose habitat in remaining areas.

Uncertainties regarding the movement of moose throughout Unit 15C remain. Snow depth appears to dictate movements to the Homer Bench and other low-lying areas, but we do not know what proportion of moose display this migratory behavior or the source locations for the migrants. Investigations into movements on the Lower Peninsula and a determination of animal locations across seasons could contribute greatly to our knowledge of population dynamics of this area. These data would help us identify and make management decisions for subpopulations of moose that are affected by severe winters and harvest pressure, and also help clarify the bull:cow ratios in specific areas during the rut. Current research being conducted in 15C (Federal Aid in Wildlife Restoration Project 1.72) should help answer some questions but continuing research that includes a bull collaring component would be useful.

Overall, the outlook for moose on the Kenai Peninsula in coming years is positive. The expansion of federal subsistence hunting opportunities and the associated increased effort by subsistence qualified users with these new opportunities however, continues to restrict the potential to allow additional hunting opportunity for the general public. This dual system will continue to challenge wildlife managers into the future.

II. Project Review and RY15–RY19 Plan

Review of Management Direction

MANAGEMENT DIRECTION

There are no new management plans or broad changes in management direction.

GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide the greatest sustained yield opportunity to participate in hunting moose.
- Provide an opportunity for nonconsumptive uses (e g. to view and photograph moose).

CODIFIED OBJECTIVES

Amount Reasonably Necessary for Subsistence Uses (ANS)

ANS objectives RY10–RY14 are expected to remain the same through RY15–19:

- C1. Units 15A and 15B have a negative Customary and Traditional Use finding for moose under 5 AAC 99.025(8):
- C2. Unit 15C has a positive Customary and Traditional Use finding of 5–6 moose in the portion southwest of a line from Point Pogibshi to the point of land between Rocky Bay and Windy Bay:

Intensive Management (IM)

The department will address the issue of proposed changes to IM objectives with the Board of Game during the 2019 Southcentral Board of Game Meeting. It is expected that the department will be recommending the following:

- Unit 15A
 - Modify existing population objective of 3,000–3,500 moose to a density of 1.5–2 moose per square mile on a sustained basis or 2,000–2,600 moose.
 - Modify the existing harvest objective of 180–350 moose so that the objective matches 5% of the lower population objective and 6% of higher population objective (100–160).
- Unit 15C
 - Reaffirm the existing population objective of 2,500–3,500 moose.
 - Modify the existing harvest objective of 200–350 moose so that it matches 5% of the lower population objective and 6% of higher population objective (125–210)

MANAGEMENT OBJECTIVES

Most RY10–RY14 management objectives remain the same for RY15–19 except that there is no longer an objective for Unit 15B-East of providing opportunities to harvest large–antlered bulls under aesthetically pleasing conditions as hunter numbers are currently minimized by area access and changing habitat conditions justify increasing harvest opportunity for more than just large-antlered bulls.

Thus, RY15–19 objectives are as follows:

M1. Maintain moose populations at a level to promote public safety through directed harvest and participate in land management decisions that affect moose movements in an effort to direct moose into areas with lower vehicle traffic.

M2. *Unit 15A*. Maintain a healthy population of moose with a posthunting bull–to–cow ratio of at least 20–25:100 in Unit 15A, except for the Skilak Loop Wildlife Management Area (SLWMA).

Primary moose management objectives in the SLWMA are to:

• Provide opportunities to view moose in a natural setting throughout the year.

- Provide opportunities to view all components of the moose community, including their behavior and habitat.
- Provide opportunities to harvest moose when a reduction in numbers is desirable to achieve other objectives.
- Achieve and maintain the resident population at 130 animals or a density of 1.8 to 2.0 moose per mi². Resident moose in excess of 130 will be available for harvest.
- Maintain a bull-to-cow ratio of at least 40 bulls:100 cows.

In addition to the resident population, moose from surrounding areas commonly winter in SLWMA. Winter populations can reach 300 animals. Habitat will be managed to provide for 130 resident and up to 170 additional wintering moose.

M3. Unit 15B–West

- Maintain a bull-to-cow ratio of 20–25:100
- Allow for maximum opportunity to participate in hunting in 15B West.

M4. Unit 15B–East

- Maintain a bull-to-cow ratio of 20–25:100.
- Maintain a healthy and productive population

M5. Unit 15C

- Maintain a bull-to-cow ratio of 20–25:100.
- Maintain a healthy and productive population

REVIEW OF MANAGEMENT ACTIVITIES

All RY10–RY14 management activities will continue through RY15–RY19. However, some changes to methods will be implemented as described below.

1. Population Status and Trend

ACTIVITY 1.1. Conduct annual composition counts in late November or early December in survey areas 2,5,8,9,10, and 13 in 15A; in the as of yet unidentified adjusted survey areas in 15B and in areas 20, 21, 24, and 26 for 15C.

Data Needs

No change in the type of data needed. Collection of data on a yearly basis would serve to better inform management.

Methods

No change in methods.

ACTIVITY 1.2. Conduct composition counts in trend area 30 for Unit 15C every 2 years.

Data Needs

No change.

Methods

No change. As possible, the frequency of flights will be increased to provide additional data.

ACTIVITY 1.3. Conduct a census to estimate population levels once every 3 years.

Data Needs

No change

Methods

Population census methods need to be improved so that surveys can take place in low snow years. Good survey conditions are becoming rarer as snow fall consistency declines. The development of new techniques such as the use of Forward Looking Infrared Radar (FLIR) and/or genetic-based census methodology need to be developed so that estimates can be produce on a reliable basis.

ACTIVITY 1.4. Research the productivity, survival, and condition of cow and calf moose in Units 15A and 15C.

Data Needs

No change.

Methods

No change.

2. Mortality-Harvest Monitoring

ACTIVITY 2.1. Monitor harvest and mortality in Unit 15 by regulatory year.

Data Needs

No change.

Methods

Development of a WinfoNet database that will include all mortality including known illegal harvest, DLPs, roadkill, trainkill, and "legal harvest" that is not properly reported on a harvest ticket is needed. Currently, WinfoNet only tracks legal harvest that is documented through a harvest ticket or permit report. Data collection methods are sufficient.

3. Habitat Assessment-Enhancement

ACTIVITY 3.1. Monitor moose browse production and removal on an annual basis to better understand sustainability of moose density.

Data Needs

No change.

Methods

Browse surveys will be instituted in all IM units and in any unit for which a population estimate is not currently achievable due to methodological limitations if time and funding allows.

ACTIVITY 3.2. Conduct habitat enhancement activities to increase moose population numbers in 15A.

Data Needs

No change.

Methods

No change.

ACTIVITY 3.3. Conduct activities to prepare for future habitat enhancement work in Unit 15B.

Data Needs

No change.

Methods

No change.

ACTIVITY 3.4. Conduct habitat enhancement activities for moose population sustainability in Unit 15C.

Data Needs

No change.

Methods

No change.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

• The current push from forces outside the department to institute predator control in management units for which it is not biologically justifiable is problematic. Predator control is a controversial management tool at best. Predator control efforts are costly and often require significant personnel time that could be spent on other pressing issues. If this tool is

not implemented wisely, public outcry could lead to expensive litigation costs and loss of an effective management tool. We will continue to exercise caution in the use of predator control and implement it only when it is biologically reasonable or when forced to do so.

• A reliable survey technique to estimate moose population numbers in years of low snow needs to be developed. In recent history, composition counts and population estimates have not been completed during the same season due to snow levels and timing and in the last 3 years population estimate surveys have not even been viable. As climate change continues, current survey techniques are likely to become less reliable for all management areas. Management staff will continue to work with research staff to develop new ways to assess population levels.

Data Recording and Archiving

- GSPE data are stored on an internal database housed on a server (http://winfonet.alaska.gov/index.cfm).
- Field data sheets will be stored in filing cabinets in the Homer Assistant Area Biologist's (AAB) office and scanned and housed on the computer server in the Homer office (O:\DWC\ADF&G-Homer Files\Species Data\Moose\Survey Data).
- Historical (pre-2010) survey notes and data sheets are stored in the Homer AAB's office and are being scanned onto the office server (O:\DWC\ADF&G-Homer Files\Species Data\Moose\Survey Data).

Agreements

• No need for management agreements exists or is projected for Unit 15.

Permitting

• No need for management related permits exist or is projected for Unit 15.

References Cited

- Alaska Department of Fish and Game. 1976. Alaska wildlife management plans: Southcentral Alaska. Draft proposal subsequently approved by the Alaska Board of Game. Division of Game, Federal Aid in Wildlife Restoration Project W-17-R, Juneau.
- Boertje, R. D., K. A. Kellie, C. T. Seaton, M. A. Keech, D. D. Young, B. W. Dale, L. G. Adams, and A. R. Aderman. 2007. Ranking Alaska moose nutrition: Signals to begin liberal antlerless harvests. Journal of Wildlife Management 71(5):1494-1506.
- Del Frate, G. G., and T. H. Spraker. 1991. Moose vehicle interactions and an associated public awareness program on the Kenai Peninsula, Alaska. Alces 27(1):1–7.

- Gasaway, W. C., S. D. Dubois, D. J. Reed, and S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biological Papers of the University of Alaska, Institute of Arctic Biology, No. 22, Fairbanks.
- Kellie, K. A., and R. A. DeLong. 2006. Geospatial survey operations manual. Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks.
- Kenai Peninsula Borough. n.d. Spruce Bark Beetle Mitigation [Internet]. Kenai Peninsula Borough [web page]. http://www.borough.kenai.ak.us/sprucebeetle (Accessed 31 May 2006).
- Nowacki, G., P. Spencer, T. Brock, M. Fleming and T. Jorgenson. 2001. Ecoregions of Alaska and neighboring territory. U.S. Geological Survey, Reston, VA.
- Paragi, T. F., C. T. Seaton, K. A. Kellie, R. D. Boertje, K. Kielland, D. D. Young Jr, M. A. Keech, and S. D. DuBois. 2015. Browse removal, plant condition, and twinning rates before and after short–term changes in moose density. Alces 51:1–21.
- Seaton, C. T.2002. Winter foraging ecology of moose in the Tanana Flats and Alaska Range foothills. Master's Thesis. University of Alaska, Fairbanks.
- Seaton, C. T., T. F. Paragi, R. D. Boertje, K. Kielland, S. Dubois, and C. L. Fleener. 2011. Browse biomass removal and nutritional condition of moose, Alces alces. Wildlife Biology17(1):55–66.
- Schwartz, C. C., and A. W. Franzmann. 1991. Interrelationship of black bears to moose and forest succession in the northern coniferous forest. Wildlife Monographs 113.
- Schwartz, C. C., K. J. Hundertmark, And T. H. Spraker. 1992. An evaluation of selective bull moose harvest on the Kenai Peninsula, Alaska. Alces 28:1–13.
- Schwartz, C. C., K. J. Hundertmark, and E. F. Becker. 1994. Growth of moose calves conceived during the first versus the second estrus. Alces 30:91–100.
- The Spike-Fork/50 Task Force. 2000. Appendix: Biological evaluation of spike-fork/50" moose harvest in Southcentral Alaska. Pages 552–587 [*In*] Hicks, M. V., editor. 2000. Moose management report survey-inventory activities 1 July 1997–30 June 1999. Alaska Department of Fish and Game, Division of Wildlife Conservation, Federal Aid in Wildlife Restoration Study 1.0, Juneau.
- U.S. Fish and Wildlife Service. 1996. Moose/habitat management plan. Kenai National Wildlife Refuge, Soldotna, Alaska.
- Wittwer, D., compiler. 2003. Forest Insect and Disease Conditions in Alaska–2002, General Technical Report R10-TP-113, U.S. Forest Service and Alaska Department of Natural Resources–Division of Forestry, Anchorage.

Ver Hoef, J. M. 2001. Predicting finite populations from spatially correlated data. Pages 93–98
 [*In*] Proceedings of the Section on Statistics and the Environment of the American Statistical Association, 13–17 August 2000, Indianapolis, Indiana.

