

Moose Management Report and Plan, Game Management Unit 20D:

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

Darren L. Bruning
Robert W. Schmidt



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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 area, 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 website.

This species management report and plan was reviewed and approved for publication by Doreen I. Parker McNeill, Region III Management Coordinator for the Division of Wildlife Conservation, Fairbanks.

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Purpose of this Report

This report provides a record of survey and inventory management activities for moose (*Alces alces*) in Unit 20D for the previous 5 regulatory years (RY; RY10–RY14) and plans for survey and inventory management activities in the 5 years following the end of that period (RY15–RY19). A regulatory year 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 them of wildlife management activities. In 2016 the Alaska Department of Fish and Game’s (ADF&G) Division of Wildlife Conservation (DWC) launched this 5-year report to more efficiently report on trends and describe potential changes in data collection activities over the next 5 years. It replaces the moose management reports of survey and inventory activities that were previously produced every 2 years and supersedes the 1976 draft Alaska wildlife management plans (ADF&G 1976).

I. RY10–RY14 Management Report

Management Area

The study area, Unit 20D, is in Interior Alaska in the Central Tanana River Valley near Delta Junction (Alaska, USA). Unit 20D encompasses 5,637 mi², but only 5,028 mi² contains topography and vegetation characteristically used by moose. The northern portion consists of the Goodpaster, Volkmar, and Healy river valleys and the Tanana Highlands with elevations ranging from 851 to 6,444 feet. The southern portion consists of the Tanana River floodplain, the lower Delta River floodplain, the Delta Agricultural Project, the drainages of the Robertson, Johnson, and Gerstle rivers, and the northern foothills and mountains of the Alaska Range with elevations varying up to 10,278 feet. Lowland vegetation is a mosaic of shrub and young forest dominated seres, climax bogs and mature black spruce (*Picea mariana*) forest. Vegetation in the hills, foothills and mountains grades from taiga at lower elevations into shrub dominated communities with alpine tundra at higher elevations. The climate is typical of Interior Alaska where temperatures frequently reach 80°F in summer –40°F in winter. Snow depths are generally below 32 inches. Most of the annual snowfall occurs during October–March. The cumulative average monthly snowfall amounts for 4 locations in Unit 20D are: 43.8 inches at Big Delta (1917–2016); 43.7 inches at Rika’s Landing (1969–1982); 57.6 inches at Clearwater (1964–1994); and 36.4 inches at Dot Lake (1905–1975). Monthly average snow depths for these 4 locations during October–March range from 1 inch in October (1905–1975) at the Dot Lake station to 15 inches in February (1964–1994) at the Clearwater station (Western Regional Climate Center 2006).

Summary of Status, Trend, Management Activities, and History of Moose in Unit 20D

Unit 20D was created in 1971 from a portion of Unit 20C. During 1962–1970, the moose hunting season in this area consisted of a 70- to 72-day bull season and a 1- to 8-day antlerless moose season. Most (51–74%) of the harvest during 1964–1970 came from the highly accessible areas near Delta Junction (Clearwater Lake, Donnelly Dome, and the Delta farming area). However,

several severe winters in the mid-1960s and early 1970s killed many moose throughout Unit 20D and other portions of Interior Alaska and set the stage for predation and hunting to compound and aggravate already widespread population declines. Poor recruitment of yearlings to the population in combination with intense bulls-only hunting depressed the bull:cow ratio to only 4:100 in the more accessible portions of the unit. The moose hunting season was closed during 1971–1973 because the depressed moose population could no longer support any significant harvest (McIlroy 1974).

Despite restrictions on hunting, the moose population in Unit 20D continued to decline because of chronically high moose mortality from other causes. In 1973 the moose population south of the Tanana River and between the Johnson and Delta Rivers was estimated at only 600. When limited moose hunting was resumed in 1974, it was conducted under a registration permit system for the entire unit; however, an area around Delta Junction was closed to moose hunting. The moose population decline in western Unit 20D was gradually reversed by a combination of continued hunting restrictions, mild winters, and wolf control in adjacent Unit 20A (1976–1982) and western Unit 20D (1980–1983).

In 1978, Unit 20D was enlarged by moving the eastern boundary from the Johnson River to the Robertson River. It was further enlarged in 1981 to include all drainages north of the Tanana River from the mouth of the Robertson River to Banner Creek.

In 1983 the closed area around Delta Junction, established in 1974, was formally named the Delta Junction Management Area (DJMA). The name of the DJMA was changed to the Delta Junction Closed Area (DJCA) in 1990 to more accurately reflect its status as an area closed to hunting. In 1991 DJCA was reduced in size to provide more hunting opportunity in the area. In 1996 DJCA was renamed DJMA because a drawing permit hunt was established in the area.

Unit 20D is subdivided into 4 areas for moose management purposes: southwestern Unit 20D, the area south of the Tanana River from the Johnson River to the Delta River; southeastern Unit 20D, the area south of the Tanana River from the Robertson River to the Johnson River; northwestern Unit 20D, the area north of the Tanana River from Banner Creek to and including the Volkmar River; and northeastern Unit 20D, the area north of the Tanana River and east of the Volkmar River.

As moose populations recovered during the mid-1970s and early 1980s, hunting opportunities were expanded in southwestern Unit 20D by first eliminating the registration permit requirement and then by lengthening the season. In southeastern and northern Unit 20D, the seasons were also increased. Antler restrictions were implemented in southwestern Unit 20D in 1988 to stabilize the increasing harvest and to improve the age structure in the bull segment of the population. In March 1995 the Alaska Board of Game (BOG) determined that the preferred use of moose in Unit 20D was for human consumption and established a moose population objective of 8,000–10,000 and an annual harvest objective of 240–500. The harvest objective was increased to 500–700 moose in 2000.

The Bison Range Youth Hunt Management Area was created in 2002 and renamed the Bison Range Controlled Use Area in 2015 to regulate moose hunting in the fields of the Delta

Junction Bison Range. This drawing permit hunt was implemented primarily to reduce the impact of moose hunting on bison management on the Bison Range.

Antlerless moose hunting began in fall 2006 in southwestern Unit 20D with a limited number of permits issued in response to a high-density population, moderate overwinter browse removal and moderately low twinning rates. The goals of the antlerless hunts were to initially reduce the population and subsequently stabilize population growth in the unit and to address concerns about range degradation, reduced nutritional conditions, and reduced reproductive success. Antlerless moose hunting in southwestern Unit 20D continued through fall 2009.

The southwestern Unit 20D moose density was reduced to a more appropriate level by the antlerless hunts. Three indices of density-dependent moose nutritional conditions—biomass removal of current annual growth on winter browse, proportion of females with twin calves, and late-winter calf weights—were evaluated in relation to changes in density. After these hunts ended in 2009 these indices were evaluated by comparing to prehunt data (prior to 2006) and data collected during the hunts. The comparison detected a decrease in winter browse removal, an increase in twinning rate, and an increase in the average weight of 9-month-old calves. There have been no antlerless hunts since the 2009 season, with the exception antlerless moose (except a cow accompanied by a calf or a calf) are legal in the Bison Range Controlled Use Area youth hunt and the disabled veteran hunt.

Entry to some military land is prohibited or restricted. This is especially controversial in those portions of Units 20D with access from highways and a highly visible moose presence.

Management Direction

EXISTING WILDLIFE MANAGEMENT PLANS

- None

GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.

CODIFIED OBJECTIVES

Amount Reasonably Necessary for Subsistence Uses

The following portions of Unit 20D have customary and traditional use findings for moose, with amounts reasonably necessary for opportunity for subsistence uses (ANS) as follows:

- Five to 15 moose in Unit 20D, that portion north of the Tanana River and outside the boundaries of the Fairbanks Nonsubsistence Area.

- Five moose in Unit 20D, that portion south of the Tanana River.

Intensive Management

- Population objective: 8,000–10,000 moose.
- Harvest objective: 500–700 moose.

MANAGEMENT OBJECTIVES

- M1. Increase the fall moose population to 8,000–10,000 moose with an annual reported sustainable harvest of 500–700 moose per year.
- M2. Manage the northern and southern Unit 20D moose populations independently (north and south of the Tanana River) for optimal population size based on indices to density-dependent nutritional limitation, to guard against eventual site-specific long-term range damage and starvation from overabundance. Moose populations will be managed for:
- a. Increasing population growth when the average 2-year prior twinning rate exceeds 20%, but a reduced rate of growth as this twinning rate average approaches 20%.
 - b. Stable population size when the 2-year prior twinning rate averages 11–20%.
 - c. Decreasing population growth when the 2-year prior twinning rate averages $\leq 10\%$.

MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Geospatial population estimation (GSPE) surveys.

Data Needs

Population status and trends are integral components of management and GSPEs are the preferred technique for this application.

Methods

We used the GSPE method (Ver Hoef 2001, 2008; Kellie and DeLong 2006) to conduct moose population estimation surveys in southern and northern Unit 20D. We maximized accuracy and precision of GSPE surveys by allocating 60% of sampling effort to the high-density stratum and 40% of effort to the low-density stratum (Kellie and DeLong 2006).

We stratified southern Unit 20D sample units (SU) as high or low density of moose based on previous stratifications and existing knowledge of the area. In general, SUs were stratified low if we expected to count < 5 moose in them. Sample units were stratified high if we expected to count ≥ 5 moose in them. In an attempt to keep variance as small as possible, we placed borderline SUs in the high stratum to minimize variance in the low stratum.

Northern Unit 20D was stratified using a Piper PA-18 Super Cub. The stratification was conducted using GSPE SUs. We stratified by flying north-south transects through the midpoint of each SU. The proportion of habitat in each SU was estimated and classified as low shrub (generally *Salix* species), tall shrub, deciduous forest, sparse spruce forest, spruce forest, or nonmoose habitat. The presence of moose tracks and number of moose seen in the SU were recorded. Before exiting the SU, it was stratified as either high or low density.

GSPE SUs are a continuous grid of squares with boundaries every 2 degrees of latitude and 5 degrees of longitude. SUs varied in size from approximately 5.7 to 5.9 mi² in Unit 20D. Each SU is identified by the latitude and longitude of its southeastern corner.

Selection of SUs was optimized for the GSPE spatial sampling design by selecting adjacent pairs of SUs distributed somewhat evenly, rather than randomly, throughout the survey area. The number of SUs to be surveyed in each stratum was divided by 2 to determine the number of SU pairs in each stratum. The adjacent pairs were selected by first randomly selecting the first SU, and then randomly selecting an adjacent SU to form the pair. The number of SU pairs that could be surveyed based on funding was determined. Then the number of SU pairs to be surveyed per stratum was divided into the total number of SU pairs to determine the number of survey blocks to be represented by a pair of SUs. We grouped SUs with similar anticipated moose densities, habitat types, and topographic features into blocks. Ten percent of available SUs were not allocated initially, but held in reserve and placed in the survey area where SUs had greater separation than 50 km. If SUs are separated by greater than 50 km, autocorrelation cannot be calculated for the population estimate (Kellie and DeLong 2006).

Sample units were surveyed with a Piper PA-18 Super Cub and flown at altitudes of approximately 300–800 feet above ground level, depending on vegetative cover. Flight speed was 60–70 mph. When terrain permitted, east-west linear transects were flown every 0.15 degrees of latitude, or north-south every 0.25 degrees of longitude. A global positioning system receiver was used to follow transect headings. In hilly or mountainous terrain, the flight path followed terrain contours within SU boundaries, rather than transects. Our objective was to spend 8–10 min/mi² of search effort in each SU sampled to achieve consistently high sightability of moose. However, large areas of nonhabitat (i.e., lakes, areas covered with ice) within these SUs were not surveyed.

We circled all moose seen to look for additional moose and to classify moose as bulls, cows, or calves. Bulls were further classified into 5 categories based on antler size and morphology: 1) yearlings with spike-fork antlers, 2) yearlings with palmate antlers, 3) medium bulls with antler spread of 31–40 inches, 4) medium bulls with antler spread 41–49 inches, and 5) large bulls with antler spread \geq 50 inches. We estimated antler spread on all medium and large bulls. We identified yearling bulls as those with antler spread <30 inches and with no antler brow palm development.

Information recorded for each SU included 1) survey start and stop times, 2) snow and light conditions, 3) major habitat type, 4) location, and 5) survey rating of excellent to poor, based on the observer's general impression.

GSPE methodology allows survey areas to be subdivided into smaller analysis areas with separate population estimates calculated for each area. In southern Unit 20D, separate population estimates were calculated for southwestern and southeastern Unit 20D for those years when GSPE surveys met the criteria. Population estimates and compositions were calculated by entering SU data into ADF&G's GSPE application software (DeLong 2006) to calculate a population estimate and composition of observable moose.

GSPE slightly underestimates the size of a moose population because it does not account for moose missed while conducting the survey. However, the moose population objective for Unit 20D is based on actual moose population size so we applied a sightability correction factor (SCF) to GSPE estimates based on recent research by Boertje and others (Boertje et al. 2009; Keech et al. 2011; R. Boertje, Wildlife Biologist, ADF&G, unpublished data, Fairbanks). An SCF of 1.21 was applied to estimates for southern Unit 20D and an SCF of 1.25 was applied to estimates for northern Unit 20D.

Population estimates in southern and northern Unit 20D were combined in some years to estimate a total unitwide estimate following the methods described in Gasaway et al. (1986). We applied the area-specific SCFs to the area population estimates. We calculated 90% binomial confidence intervals (CI) around population estimates and composition ratios using GSPE tools in ADF&G's Wildlife Information Network (WinfoNet; <https://winfonet.alaska.gov/>) server (Kellie and DeLong 2006) for comparisons with management objective thresholds (i.e., 12,000–15,000 moose; 30 bulls:100 cows).

Fall 2010

The southern Unit 20D (south of the Tanana River) GSPE survey was flown during 17 November–1 December 2010 and cost \$15,290. This survey area included 320 SUs and covered 1,890 mi² averaging 5.9 mi²/SU. The high-density stratum had 189 SUs totaling approximately 1,116 mi² and the low-density stratum had 131 SUs totaling 775 mi². Seventy-six SUs were searched including 51 high-density (67%) and 25 low density (33%), meeting the objective of surveying 60% high-density SUs. Search effort during this survey met the objective in high density SUs and averaged 47 min/SU (8.0 min/mi²) but did not meet the objective in low density SUs that averaged 41 min/SU (7.0 min/mi²).

The southern Unit 20D GSPE survey results were subdivided into 2 analysis areas of
1) southeastern Unit 20D (SE) south of the Tanana River and east of the Johnson River, and
2) southwestern Unit 20D (SW) south of the Tanana River and west of the Johnson River.

Fall 2011

The GSPE survey in southern Unit 20D during 2–23 November 2011 cost \$9,490. This survey area included 320 SUs and covered 1,890.2 mi², averaging 5.9 mi²/SU. The high-density stratum had 186 SUs totaling approximately 1,098.2 mi² and the low-density stratum had 134 SUs totaling 792.0 mi². We searched 64 SUs including 44 high density (73%) and 20 low density (31%), meeting the objective of surveying 60% high-density SUs. Search effort during this survey did not meet the objective. Search effort in high-density SUs averaged 42.7 min/SU (7.1 min/mi²). Search effort in low-density SUs averaged 39.7 min/SU (6.60 min/mi²). Survey

conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were mostly excellent (46%) and good (44%) with the remainder being fair (8%) and poor (2%) ($n = 122$).

Fall 2012 – Southern Unit 20D

The southern Unit 20D (south of the Tanana River) GSPE survey was flown during 5 November–12 December 2012 and cost \$8,960. This survey area included 320 SUs and covered 1,890 mi² averaging 5.9 mi²/SU. The high-density stratum had 189 SUs totaling approximately 1,116 mi² and the low-density stratum had 131 SUs totaling 775 mi². Fifty SUs were searched including 30 high density (60%) and 20 low density (43%), meeting the objective of surveying 60% high-density SUs. Search effort during this survey met the objective in high-density SUs and averaged 46.1 min/SU (7.7 min/mi²) but did not meet the objective in low-density SUs that averaged 44.1 min/SU (7.4 min/mi²). Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were mostly excellent (46%) and good (44%) with the remainder being fair (8%) and poor (2%) ($n = 122$).

Fall 2012 – Northern Unit 20D

The northern Unit 20D (north of the Tanana River) stratification survey occurred during 1–12 November. Two hundred fifty-eight SUs were stratified as high density and 288 were stratified as low density.

The northern Unit 20D GSPE survey was flown during 17 November–11 December 2012 and cost \$13,360. This survey area included 546 SUs and covered 3,174 mi² averaging 5.8 mi²/SU. The high-density stratum had 262 SUs totaling approximately 1,520 mi² and the low-density stratum had 284 SUs totaling 1,653 mi². Fifty-three SUs were searched including 32 high density (60%) and 21 low density (40%), meeting the objective of surveying 60% high-density SUs. Search effort during this survey met the objective in high-density SUs and averaged 45.4 min/SU (7.8 min/mi²) but did not meet the objective in low-density SUs that averaged 43.8 min/SU (7.6 min/mi²).

Fall 2013

The GSPE survey in southern Unit 20D during 15 November–9 December 2013 cost \$22,320. This survey area included 320 SUs and covered 1,890.2 mi² averaging 5.9 mi²/SU. The high-density stratum had 186 SUs totaling approximately 1,098.2 mi² and the low-density stratum had 134 SUs totaling 792.0 mi². We searched 88 SUs including 68 high-density (77%) and 20 low-density (23%), meeting the objective of surveying 60% high-density SUs. Search effort in high-density SUs averaged 47.5 min/SU (8.0 min/mi²). Search effort in low-density SUs averaged 46.8 min/SU (7.9 min/mi²). Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were mostly good (58%) with the remainder being excellent (21%) and fair (21%; $n = 57$).

Fall 2014

The GSPE survey in southern Unit 20D during 5 November–3 December 2014 cost \$17,260. This survey area included 320 SUs and covered 1,890.2 mi² averaging 5.9 mi²/SU. The high-density stratum had 186 SUs totaling approximately 1,098.2 mi² and the low-density stratum had 134 SUs totaling 792.0 mi². We searched 74 SUs including 43 high density (58%) and 31 low density (42%), therefore, not meeting the objective of surveying 60% high-density SUs. Search effort in high density SUs averaged 45.5 min/SU (7.7 min/mi²). Search effort in low density SUs averaged 37.4 min/SU (6.34 min/mi²). Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were mostly good (49%) and excellent (36%) with the remainder being fair (15%; $n = 74$).

Fall 2015

The northern Unit 20D GSPE survey was flown during 22 November–9 December 2015 and cost \$9,200. This survey area included 546 SUs and covered 3,174 mi² averaging 5.8 mi²/SU. The high-density stratum had 262 SUs totaling approximately 1,520 mi² and the low-density stratum had 284 SUs totaling 1,653 mi². Sixty-three SUs were searched including 38 high density (60%) and 25 low density (40%), meeting the objective of surveying 60% high-density SUs. Search effort during this survey met the objective in high-density SUs and averaged 45.0 min/SU (7.7 min/mi²) but did not meet the objective in low-density SUs that averaged 42.0 min/SU (7.2 min/mi²). Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were mostly good (63%) and excellent (32%) and with the remainder being fair (5%) and poor (2%; $n = 63$).

Results

2010

Southern Unit 20D — The population estimate was 4,574 observable moose (without an SCF applied, Table 1) with a 90% CI of 3,734–5,414 moose. Applying an SCF of 1.21 to the estimate resulted in a sightability-corrected estimate of 5,534 moose for a density of 2.9 moose/mi². The southern Unit 20D population composition from the fall 2010 GSPE survey was 26 calves:100 cows (range = 19–32) and 33 bulls:100 cows (range = 23–43; Table 1).

Southeastern and Southwestern Unit 20D — The SE Unit 20D analysis area had a population estimate of 976 observable moose (Table 2) and 1,180 moose with a 1.21 SCF applied, resulting in 1.9 moose/mi².

The SW Unit 20D analysis area had a population estimate of 3,599 observable moose (Table 2) and 4,354 with a 1.21 SCF applied, resulting in a density of 3.5 moose/mi².

The SE Unit 20D analysis area had composition of 28 calves:100 cows (range = 8–49) and 35 bulls:100 cows (range = 15–55) (Table 1). The SW Unit 20D analysis area had composition of 25 calves:100 cows (range = 19–32) and 32 bulls:100 cows (range = 23–42) (Table 2).

Table 1. Results of population estimates of observed moose for southern Unit 20D using geospatial population estimator (GSPE) surveys, Interior Alaska, 2010–2015.

Year/Method	Total population estimate	Total cows	Total calves	Total bulls	Calves: 100 cows	Bulls:100 cows
2010	4,574	2,888	755	968	26	33
(LCI–UCI) ^a	3,734–5,414	2,310–3,466	610–900	753–1,182	19–32	23–43
2011	4,134	2,497	888	757	35	30
(LCI–UCI) ^a	3,162–5,106	1,940–3,055	686–1,091	497–1,016	31–40	22–38
2012	4,450	2,640	805	975	30	37
(LCI–UCI)	3,618–5,284	2,112–3,167	590–1,019	708–1,242	24–38	27–47
2013 ^b						
(LCI–UCI)						
2014 ^b						
(LCI–UCI)						
2015 ^c						
(LCI–UCI)						

^a LCI = lower confidence interval at 90% and UCI = upper confidence interval at 90%.

^b No population estimate generated.

^c No survey.

Table 2. Results of population estimates of observed moose for southeastern Unit 20D (east of the Johnson River) using geospatial population estimator (GSPE) surveys, Interior Alaska, 2010–2015.

Parameter	2010	2011	2012	2013 ^a	2014 ^a	2015 ^b
Total pop estimate	976	791	1,164			
LCI ^c	594	374	816			
UCI ^d	1,357	1,208	1,512			
Total cows	608	494	687			
LCI	346	254	442			
UCI	869	734	932			
Total calves	165	155	150			
LCI	100	67	46			
UCI	231	243	255			
Total bulls	220	159	267			
LCI	132	62	167			
UCI	307	257	368			
Bulls:100 Cows	35	31	39			
LCI	15	16	21			
UCI	55	46	56			
Calves:100 Cows	28	35	30			
LCI	8	31	24			
UCI	49	40	38			

^a No population estimate generated.

^b No survey.

^c LCI = lower confidence interval.

^d UCI = upper confidence interval.

The southern Unit 20D population composition from the fall 2010 GSPE survey was 26 calves:100 cows (range = 19–32) and 33 bulls:100 cows (range = 23–43; Table 1).

The SE Unit 20D analysis area had composition of 28 calves:100 cows (range = 8–49) and 35 bulls:100 cows (range = 15–55) (Table 2).

The SW Unit 20D analysis area had composition of 25 calves:100 cows (range = 19–32) and 32 bulls:100 cows (range = 23–42) (Table 3).

2011

Southern Unit 20D – The southern Unit 20D population estimate was 4,134 observable moose (without an SCF applied, Table 1) with a 90% CI of 3,162–5,106. Applying a 1.21 SCF to the estimate resulted in an SCF-corrected estimate of 5,002 moose (2.6 moose/mi²). The southern Unit 20D population composition from the fall 2011 GSPE survey was 35 calves:100 cows (range = 31–40) and 30 bulls:100 cows (range = 22–38; Table 1).

Southeastern and Southwestern Unit 20D — The southern Unit 20D GSPE survey results were subdivided into 2 analysis areas of 1) southeastern Unit 20D (SE) south of the Tanana River and east of the Johnson River, and 2) southwestern Unit 20D (SW) south of the Tanana River and west of the Johnson River. The SE Unit 20D analysis area had a population estimate of 791 observable moose (Table 2) and 957 with a 1.21 SCF applied, resulting in 1.6 moose/mi². The SE Unit 20D analysis area had composition of 35 calves:100 cows (range = 31–40) and 31 bulls:100 cows (range = 16–46) (Table 2). The SW Unit 20D population estimate was 3,343 observable moose (Table 3) and 4,045 with a 1.21 SCF applied, resulting in a density of 3.1 moose/mi². The SW Unit 20D analysis area had composition of 37 calves:100 cows (range = 32–41) and 30 bulls:100 cows (range = 22–38; Table 3).

2012

Southern Unit 20D — The southern Unit 20D population estimate was 4,450 observable moose (without an SCF applied, Table 1) with a 90% CI of 3,618–5,284 moose. Applying an SCF of 1.21 to the estimate resulted in a sightability-corrected estimate of 5,385 moose for a density of 2.8 moose/mi². The southern Unit 20D population composition from the fall 2012 GSPE survey was 30 calves:100 cows (range = 24–38) and 37 bulls:100 cows (range = 27–47; Table 1).

Southeastern and Southwestern Unit 20D — The southern Unit 20D GSPE survey results were subdivided into 2 analysis areas of 1) southeastern Unit 20D (SE) south of the Tanana River and east of the Johnson River, and 2) southwestern Unit 20D (SW) south of the Tanana River and west of the Johnson River. The SE Unit 20D analysis area had a population estimate of 1,164 observable moose (Table 2) and 1,408 moose with a 1.21 SCF applied, resulting in 2.3 moose/mi². The SE Unit 20D analysis area had composition of 30 calves:100 cows (range = 24–38) and 39 bulls:100 cows (range = 21–56; Table 2). The SW Unit 20D analysis area had a population estimate of 3,286 observable moose (Table 3) and 3,976 with a 1.21 SCF applied,

Table 3. Results of population estimates of observed moose for southwestern Unit 20D (west of Johnson River) using geospatial population estimator (GSPE) surveys, Interior Alaska, 2010–2015.

Parameter	2010	2011	2012	2013	2014	2015 ^c
Total pop estimate	3,599	3,343	3,286	3,649	3,572	
LCI ^a	2,957	2,559	2,690	2,834	2,756	
UCI ^b	4,239	4,127	3,882	4,464	4,387	
Total cows	2,280	2,003	1,952	2,085	2,048	
LCI	1,838	1,555	1,586	1,604	1,600	
UCI	2,722	2,452	2,310	2,534	2,496	
Total calves	589	733	654	777	780	
LCI	478	571	498	615	624	
UCI	699	896	810	935	936	
Total bulls	748	597	707	630	650	
LCI	583	392	514	425	457	
UCI	912	802	901	835	843	
Bulls:100 Cows	32	30	36	30	32	
LCI	23	22	27	22	24	
UCI	42	38	45	38	40	
Calves:100 Cows	25	37	34	37	38	
LCI	19	32	28	32	33	
UCI	32	41	40	41	43	

^a LCI = lower confidence interval.

^b UCI = upper confidence interval.

^c No survey.

resulting in a density of 3.1 moose/mi². The SW Unit 20D analysis area had composition of 34 calves:100 cows (range = 28–40) and 36 bulls:100 cows (range = 27–45; Table 3).

Northern Unit 20D — The population estimate was 2,406 observable moose (without an SCF applied, Table 4) with a 90% CI of 1,811–3,001 moose. Applying an SCF of 1.25 to the estimate resulted in a sightability-corrected estimate of 3,008 moose for a density of 0.9 moose/mi². The northern Unit 20D population composition from the fall 2012 GSPE survey was 13 calves:100 cows (range = 8–19) and 59 bulls:100 cows (range = 35–84; Table 4).

Unitwide Population Estimate —The 2012 southern and northern Unit 20D population estimates were combined to calculate a Unit 20D total population estimate of 6,856 observable moose.

2013

Southeastern Unit 20D — No GSPE population estimate was generated in fall 2013.

Southwestern Unit 20D — The SW Unit 20D population estimate was 3,649 observable moose (Table 3) and 4,415 with a 1.21 SCF applied, resulting in a density of 3.5 moose/mi². The SW Unit 20D analysis area had composition of 37 calves:100 cows (range = 32–41) and 30 bulls:100 cows (range = 22–38; Table 3).

2014

Southeastern Unit 20D — No GSPE population estimate was generated in fall 2014.

Southwestern Unit 20D — The SW Unit 20D population estimate was 3,572 observable moose (without an SCF applied, Table 3) with a 90% CI of 2,756–4,387. Applying a 1.21 SCF to the estimate resulted in an SCF-corrected estimate of 4,321 moose (3.4 moose/mi²). The SW Unit 20D population composition from the fall 2014 GSPE survey was 38 calves:100 cows (range = 34–43) and 32 bulls:100 cows (range = 24–40; Table 3).

2015

Southern (Southwestern and Southeastern) Unit 20D — No GSPE survey was conducted in fall 2015.

Northern Unit 20D — The population estimate was 3,187 observable moose (without an SCF applied, Table 4) with a 90% CI of 2,550–3,824 moose. Applying an SCF of 1.25 to the estimate resulted in a sightability-corrected estimate of 3,984 moose for a density of 1.26 moose/mi². The northern Unit 20D population composition from the fall 2015 GSPE survey was 23 calves:100 cows (range = 17–30) and 41 bulls:100 cows (range = 26–55; Table 4).

Table 4. Results of population estimates of observed moose for northern Unit 20D using a geospatial population estimator (GSPE) survey, Interior Alaska, 2004–2015.

Parameter	2004 GSPE ^a	2012 GSPE ^a	2015 GSPE ^a
Total estimate	1,929	2,406	3,187
LCI ^b	1,443	1,811	2,550
UCI ^c	2,415	3,001	3,824
Total bulls	515	828	803
LCI	351	524	534
UCI	679	1,133	1,071
Total cows	1,202	1,393	1,980
LCI	776	1,052	1,549
UCI	1,426	1,733	2,411
Total calves	338	184	458
LCI	189	114	336
UCI	486	255	580
Bulls:100 cows	47	59	41
LCI	28	35	26
UCI	66	84	55
Calves:100 cows	31	13	23
LCI	19	8	17
UCI	43	19	30

^a GSPE is a geospatial population estimator survey conducted with a higher search intensity than the Gasaway method, but without a sightability correction factor applied to the observable moose estimate. Northern Unit 20D was surveyed in its entirety each GSPE survey.

^b LCI = lower confidence interval.

^c UCI = upper confidence interval.

Recommendations for Activity 1.1

- Continue GSPE surveys in SW Unit 20D a minimum of 4 out of 5 years in order to monitor and evaluate trends in abundance, productivity, recruitment, and bull escapement.
- Continue evaluation of trends in the moose population's productivity (calves:100 cows), and sustainable bull harvests (bulls:100 cows) in SW Unit 20D a minimum of 4 out of 5 years.
- Continue GSPE surveys in the entire southern Unit 20D a minimum of 3 out of 5 years in order to monitor and evaluate trends in abundance, productivity, recruitment, and bull escapement.
- Continue evaluation of trends in the moose population's productivity (calves:100 cows), and sustainable bull harvests (bulls:100 cows) in the entire southern Unit 20D a minimum of 3 out of 5 years.

- Continue GSPE surveys in northern Unit 20D a minimum of once every 4 years in order to monitor and evaluate trends in abundance, productivity, recruitment, and bull escapement.
- Continue evaluation of trends in the moose population's productivity (calves:100 cows), and sustainable bull harvests (bulls:100 cows) in northern Unit 20D a minimum of once every 4 years.
- Incorporate SCF trials into GSPEs once every 5 years for southern/SW Unit 20D and once every 8 years for northern Unit 20D to improve population estimate and trend.

ACTIVITY 1.2. Spring twinning surveys.

Data Needs

Estimates of the moose population's nutritional condition and productivity are integral to management on a sustained yield basis over the long-term and twinning rates are an index of density-dependent moose nutritional condition.

Methods

Surveys were flown in a Piper PA-18 at 300–700 feet above ground level at approximately 60–70 mph by flying linear transects spaced approximately 0.25 miles apart. The survey objective was to observe a sample of 50 cows with calves. Large areas where there was little chance of spotting a moose (i.e., large agricultural grain fields, areas of dense spruce) were not surveyed.

Twinning survey SUs were drawn on 1:63,360 scale U.S. Geological Survey topographic maps using topographic features as boundaries. Twinning surveys were flown in 8 SUs totaling approximately 139.5 mi² south of the Tanana River between the Gerstle and Delta rivers (southwestern Unit 20D). The SUs surveyed include Big Lake (19.5 mi²), Butch Lake (17.5 mi²), Clearwater Lake (12.5 mi²), Donnelly (17.5 mi²), Gerstle (15.5 mi²), Ober Creek (34 mi²), Pump Station #9 (16.5 mi²), and Sawmill Creek North (6.5 mi²). In addition to surveying the SUs listed above, we classified and recorded moose observed while flying in route to SUs.

When moose were spotted, a low pass was made to determine the sex and to look for newborn calves. Moose ≥1-year old with visible antlers were classified as bulls; all others were classified as cows. If no calves were observed with cows, 2–4 additional low passes were made over the cow to improve sightability of calves, if present. Data recorded for each observation included the sex of the moose, the presence or absence and number of calves or yearling offspring, and the moose location. Twinning rates were calculated by dividing the total number of cows seen with any calves at heel (single or twins) by the number of cows seen with twins at heel.

Results

Spring 2011 Twinning Surveys

Aerial twinning surveys in southwestern Unit 20D were flown during 27–30 May 2011 in 11.2 hours of survey time and cost \$3,300. We spotted 29.0 moose/hr, with 325 moose observed including 66 cow–calf groups with 17 (25.8%) being cows with twins (Table 5).

Spring 2012 Twinning Surveys

Aerial twinning surveys in southwestern Unit 20D were flown during 28 May–2 June 2012 in 14.1 hours of survey time and cost \$4,900. We spotted 20.5 moose/hr, with 300 moose observed including 59 cow–calf groups with 8 (13.6%) being cows with twins (Table 5).

Spring 2013 Twinning Surveys

Aerial twinning surveys in southwestern Unit 20D were flown during 28–30 May 2013 for a total of 9.1 hours of survey time and cost \$2,580. We saw 26.0 moose/hr, with 246 moose observed including 54 cow–calf groups with 14 (25.9%) being cows with twins (Table 5).

Spring 2014 Twinning Surveys

Aerial twinning surveys in southwestern Unit 20D were flown during 1–4 June 2014 for a total of 11.5 hours of survey time and cost \$1,600. We saw 18.6 moose/hr, with 214 moose observed including 55 cow–calf groups with 13 (24%) being cows with twins (Table 5).

Spring 2015 Twinning Surveys

Aerial twinning surveys in southwestern Unit 20D were flown during 27–28 May 2015 for a total of 10.5 hours of survey time and cost \$2,100. We saw 22.2 moose/hr, with 224 moose observed including 53 cow–calf groups with 7 (13%) being cows with twins (Table 5).

Spring 2016 Twinning Surveys

Aerial twinning surveys in southwestern Unit 20D were flown during 23–29 May 2016 for a total of 14.8 hours of survey time and cost \$2,960. We saw 18.5 moose/hr, with 274 moose observed including 62 cow–calf groups with 9 (14.5%) being cows with twins (Table 5).

Recommendations for Activity 1.2

- Continue spring twinning rate surveys.

Table 5. Results of moose twinning surveys in Southwest Unit 20D, Interior Alaska, 2011–2016.

Year	Cows w/single calves	Cows w/twin calves	% Cows w/twins	Moose per hour	Total moose
2011	49	17	25.8	29.0	325
2012	51	8	13.6	20.5	300
2013	40	14	25.9	26.0	246
2014	42	13	24.0	18.6	214
2015	46	7	13.0	22.2	224
2016	53	9	14.5	18.5	274

2. Mortality–Harvest Monitoring and Regulations

ACTIVITY 2.1. Monitor and analyze harvest data.

Data Needs

Unit 20D was identified by BOG for intensive management (IM) of moose with a harvest objective of 500–700 moose annually.

Methods

We estimated annual harvest from mandatory harvest report cards. Harvest data were summarized by regulatory year. This included data from report cards from the harvest ticket hunt, drawing hunts (i.e., bull hunt DM790, Disabled Veteran hunt any moose hunt DM795, and the Bison Range Controlled Use Area youth hunt YM792). Hunters received 1 or 2 reminder letters and usually an e-mail and telephone calls if we did not receive timely harvest reports. We summarized hunter residency, and hunter success data.

We estimated total take by humans including unreported harvest (Gasaway et al. 1992), other types of reported mortality (i.e., defense of life or property, dispatched, potlatch, vehicle collision), and unreported mortality (i.e., illegal, snaring, other, and wounding loss) caused by humans. We compared total annual reported harvest to the lower limit of the IM harvest objective.

Results

Harvest by Hunters

RY10 — Estimated moose mortality from all human causes in RY10 was 340 moose (Table 6); however this did not include an estimate of illegally taken moose, which is thought to be high but is undocumented. This total included 245 moose reported killed by hunters in fall 2010, an estimated unreported harvest of 43 moose, and an estimated 52 moose killed by highway vehicles (the average of the last 3 years of known vehicle collision mortality). The total reported hunting mortality of 245 did not meet the harvest objective for Unit 20D.

RY11 — Estimated moose mortality from all human causes in RY11 was 376 moose (Table 6). This total included 279 moose reported killed by hunters in fall 2011, an estimated unreported harvest of 49 moose, no estimate for illegal harvest, and an estimated 48 moose killed in vehicle collisions (the average of the last 2 years of known vehicle collision mortality). Illegal harvest is undocumented. The total reported hunting mortality of 279 did not meet the IM harvest objective for Unit 20D.

RY12 — Estimated moose mortality from all human causes in RY12 was 360 moose (Table 6); however this did not include an estimate of illegally taken moose, which was thought to be high but is undocumented. This total included 265 moose reported killed by hunters in fall 2012, an estimated unreported harvest of 47 moose, and an estimated 48 moose killed by highway vehicles (the average of the last 2 years of known vehicle collision mortality). The total reported hunting mortality of 265 did not meet the IM harvest objective for Unit 20D.

RY13 — Estimated moose mortality from all human causes in RY13 was 326 moose (Table 6). This total included 236 moose reported killed by hunters in fall 2013, an estimated unreported harvest of 42 moose, and an estimated 48 moose killed in vehicle collisions (the average of the last 2 years of known vehicle collision mortality). Illegal harvest is undocumented. The total reported hunting mortality of 236 did not meet the IM harvest objective for Unit 20D.

RY14 — Estimated moose mortality from all human causes in RY14 was 379 moose (Table 6). This total included 281 moose reported killed by hunters in fall 2014, an estimated unreported harvest of 50 moose, and an estimated 48 moose killed in vehicle collisions (the average of the last 2 years of known vehicle collision mortality). Illegal harvest is undocumented. The total reported hunting mortality of 281 did not meet the IM harvest objective for Unit 20D.

RY15 — Estimated moose mortality from all human causes in RY15 was 365 moose (Table 6). This total included 279 moose reported killed by hunters in fall 2015, an estimated unreported harvest of 49 moose, and 37 moose reported to be killed in vehicle collisions. Illegal harvest is undocumented. The total reported hunting mortality of 279 did not meet the IM harvest objective for Unit 20D.

Hunter Residency and Success

Based on harvest reports, the majority of Unit 20D hunters during RY11–RY15 were Alaska residents who resided outside of Unit 20D. The proportion of nonresident hunters continued to be low. Success rates (5-year average = 26%) during the general season were stable during RY11–RY15. Nonresidents had higher success rates than residents. During RY11–RY15, the 5-year average success rate was 36% for nonresident hunters compared to 25% for resident hunters (Table 7). Drawing permit hunts DM790, DM795, and YM792 contributed minimal additional harvest of bulls ($n = 61$) and antlerless moose ($n = 42$) during RY10–RY15 (Tables 8 and 9).

Recommendations for Activity 2.1

- Continue to monitor total harvest for comparison with the IM harvest objective.
- Modify comparisons of reported harvest to the lower threshold of the IM harvest objective using 3-year running means to account for annual variability.

3. Habitat Assessment–Enhancement

None.

Table 6. Unit 20D moose harvest and accidental death, Interior Alaska, regulatory years^a 2010–2015.

Regulatory year	Harvest by hunters							Accidental death			
	M	Reported F	Unk	Total	Unreported ^b	Estimated Illegal	Total	Road	Other	Total	Total
2010	239	6	0	245	43	Unk	43	52 ^c	0	52	340
2011	272	7	0	279	49	Unk	49	48 ^c	0	48	376
2012	257	8	0	265	47	Unk	47	48 ^c	0	48	360
2013	226	10	0	236	42	Unk	42	48 ^c	0	48	326
2014	277	3	1	281	50	Unk	50	48 ^c	0	48	379
2015	269	9	1	279	49	Unk	49	37	0	37	365

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

^b Based on 17.7% unreported harvest estimated by Gasaway et al. (1992).

^c Two-year average of the last 2 known years.

Table 7. Unit 20D harvest ticket hunting season moose hunter residency and success^a, Interior Alaska, regulatory years^b 2010–2015.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local ^c resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local ^c resident	Nonlocal resident	Nonresident	Unk	Total (%)	
2010	66	159	15	2	242 (27)	192	428	33	13	666 (73)	908
2011	69	166	18	5	258 (30)	156	408	29	12	605 (70)	863
2012	67	153	23	5	248 (26)	184	472	34	20	710 (74)	958
2013	65	129	20	1	215 (21)	227	519	68	5	819 (79)	1,034
2014	63	172	27	1	263 (25)	246	483	40	1	770 (75)	1,033
2015	55	172	30	1	258 (26)	215	479	46	1	741 (74)	999

^a Excludes hunters in permit hunts.

^b A regulatory year begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.

^c Local means the hunter resides in Unit 20D.

Table 8. Unit 20D Delta Junction Management Area moose drawing permit harvest, Interior Alaska, regulatory years^a 2010–2015.

Hunt	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Percent bulls	Percent cows	Unk	Harvest
DM795	2010	6	17	60	40	100	0	0	2
DM790	2011	19	16	31	69	100	0	0	11
DM795	2011	6	33	50	50	100	0	0	2
DM790	2012	19	26	29	71	90	10	0	10
DM795	2012	6	50	100	0	0	0	0	0
DM790	2013	19	21	47	53	100	0	0	8
DM795	2013	6	50	0	100	100	0	0	3
DM790	2014	19	11	47	53	100	0	0	9
DM795	2014	6	0	33	67	100	0	0	4
DM790	2015	19	16	31	69	100	0	0	11
DM795	2015	8	50 ^b	25	75	66	33	0	3

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

^b In 2015 DM795 permit conditions changed to require qualified applicants to hold a Purple Heart and to have incurred 100% service-connected disability. Three of the original permit winners were ineligible and therefore did not hunt.

Table 9. Unit 20D Bison Range Youth Hunt Management Area moose drawing permit harvest, Interior Alaska, regulatory years^a 2010–2015.

Hunt	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Percent bulls	Percent cows	Unk	Harvest
DM792	2010	10	0	40	60	0	100	0	6
DM792	2011	10	10	11	89	13	87	0	8
DM792	2012	10	0	30	70	14	86	0	7
DM792	2013	11	9	0	100	0	100	0	10
DM792	2014	10	10	44	56	40	60	0	5
YM792 ^b	2015	10	10	11	89	0	100	0	8

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

^b Permit named changed from DM792 to YM792.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

The United States (U.S.) Army Garrison Fort Greely requested assistance to address the hazards posed by the presence of moose within the fenced perimeter of Allen Army Airfield. Fort Greely asked ADF&G Delta Area office to anesthetize moose and transport them outside of the fenced areas of Fort Greely. ADF&G Delta Area staff made multiple site visits to Fort Greely during RY11–RY15 and provided an assessment of the situation and technical assistance to the U.S. Army. The primary issue that was identified was the failure of the perimeter fence to exclude moose from the airfield. Beginning in 2014, Fort Greely began modifying the perimeter fence of Allen Army Airfield for the purpose of excluding ungulates. When fencing is complete, wildlife that remains in the airfield area will be removed by ADF&G.

The presence of moose on the remainder of Fort Greely is also an ongoing concern with members of the Delta Junction community. Though there is no complete perimeter fence around the entire of Fort Greely, there is a network of interior fences that give the appearance that moose are hindered from free movement in and out of Fort Greely. ADF&G Delta Area office staff have discussed the need for water sources in the interior of Fort Greely and the installation of “moose escape hatches” in key locations in fencelines within the perimeter.

U.S. Army, Fort Wainwright Donnelly Training Area (DTA) East is located within southwest Unit 20D. The training area has a high density of moose and very good access for hunters. The closure of DTA for military use has at times conflicted with moose hunting seasons. We need to continue to coordinate with Fort Wainwright in providing information to southwest Unit 20D about DTA closures that occur during moose hunting seasons.

Data Recording and Archiving

ARCHIVING

- GSPE data are stored in a moose database on ADF&G’s Wildlife Information Network (WinfoNet; <http://winfonet.alaska.gov/index.cfm>), an internal server. Field data sheets are stored in a file cabinet in the Delta Area Biologist’s office at ADF&G’s Delta Area office (MP 266.8, Richardson Highway, Delta Junction, Alaska).
- All other electronic data are located on the computer in the Delta Area Biologist’s office at ADF&G’s Delta Area office. Field data sheets, paper files, hard copies, etc. are located in a file cabinet located in the Delta Area Biologist’s office.

Agreements

- U.S. Army Fort Wainwright Cooperative Agreement dated 30 June 2012.

Permitting

None.

Conclusions and Management Recommendations

Moose densities in southwestern Unit 20D remained relatively high at an estimated 3.1–3.5 moose/mi² during RY10–RY14. Though the moose density in southwestern Unit 20D was relatively high, it remains lower than the density prior to the antlerless moose hunts during RY06–RY09 (DuBois 2010). After antlerless moose hunts reduced the population, 3 indices of density-dependent moose nutritional conditions — biomass removal of current annual growth on winter browse, proportion of females with twin calves, and late-winter calf weights — were evaluated in relation to changes in density. This evaluation was compared to data collected prior to and during the reduction. The comparison detected a decrease in winter browse removal (T. Paragi, Wildlife Biologist, ADF&G, unpublished data, Fairbanks), an overall increase in twinning rate, and an increase in the average weight of 9-month-old calves (K. A. K. Seaton, Wildlife Biologist, ADF&G, unpublished data, Fairbanks). There have been few antlerless permits issued since the 2009 season, except that an antlerless moose (except a cow accompanied by a calf or a calf) is part of the legal bag limit in the Bison Range Youth Moose Hunt and antlerless moose (except a cow accompanied by a calf or a calf) became part of the legal bag limit for the DM795 Disabled Veterans hunt in RY15.

The southwestern Unit 20D moose population was stable during 2010–2014, peaking at about 3,649 observable moose in fall 2013. Bull:cow ratios in southwest Unit 20D were also stable during 2010–2014 and we met our objective of >20 bulls:100 cows in southwestern Unit 20D during 2010–2014. We do not have a SW Unit 20D population or density estimate, or calculated bull:cow ratios for 2015 because available funding and resources were devoted to survey and population estimate for northern Unit 20D. Twinning rates in southwestern Unit 20D increased in 2011 but decreased in 2012. A spike in twinning rates was documented throughout a substantial portion of Interior Alaska in 2011 (K. A. K. Seaton, personal communication), and may not have been indicative of a trend in Unit 20D. Based on the average twinning rate during spring 2011–2015 of 20.4%, we are managing the Unit 20D moose population for zero growth.

The estimate of observable moose in northern Unit 20D was higher in 2015 than in 2012, and continues the trend of an increasing estimate of observable moose in northern Unit 20D since 2004 (Table 4). It is possible the population increased in response to habitat enhancement that occurred due to wildland fires since 2003. These fires changed plant community succession to earlier stages in a substantial area of northern Unit 20D, with a cumulative burn footprint since 2011 of approximately 77,400 acres (Alaska Interagency Coordination Center Fire History 2016). These earlier stages of plant community succession likely provided increased availability and increased nutritional value of forage to moose (Peek 2007), which in turn has contributed to increased numbers of moose.

During fall 2010–2014 the Unit 20D moose population was not estimated to be within the population objective of 8,000–10,000 moose set by BOG. The stable population estimates, bull:cow, and calf:cow ratios in Southwest Unit 20D (the area of Unit 20D with the highest moose density) during fall 2010–2014 suggest the population may not be capable of increasing to the IM population objective without causing negative impacts to habitat and moose production. Due to wildfire within the last 13 years, it is possible the moose population could continue to increase in northern Unit 20D. An increased number of moose in northern Unit 20D would contribute to increasing the overall Unit 20D moose population, but it will be unlikely for the

overall Unit 20D moose population to reach the lower IM population objective unless there is widespread plant community successional setback throughout the unit.

The harvest objective of 500–700 moose was not met on any year during RY10–RY14. To meet this harvest objective, it will be necessary to harvest moose at a rate that cannot be sustained with the current population. We are currently managing for a stable population, and as indicated by the stability of the bull harvest, the overall positive feedback from the Delta Fish and Game Advisory Committee, and the anecdotal attitude of hunting satisfaction portrayed by the general public, the structure of Unit 20D moose hunts appears to be maximizing a significant and acceptable amount of the harvestable surplus of moose. No changes are planned for the general season hunt. However, a proposal should be considered for the next BOG cycle to adjust the IM population and harvest objectives to sustainable numbers.

Antlerless moose hunting in Unit 20D has only occurred (in recent history) within the southwest portion of the unit, which contains the highest moose densities. Existing Unit 20D hunts YM792 and DM795 have an antlerless moose (except a cow accompanied by a calf or a calf) as part of the legal bag limit, and allow for the combined maximum potential harvest of 16 antlerless moose. Based on analysis of population status and trends of the southwest Unit 20D moose population, the potential harvest from these 2 hunts, added to the antlerless take of ceremonial harvest and the mortalities of antlerless moose caused by vehicle collision and other mortality factors, appears to be a rate of mortality that contributes to stability in the southwest Unit 20D moose population. The conservative harvest of antlerless moose is wholly supported by the Delta Fish and Game Advisory Committee, and they have requested the re-initiation of an antlerless moose hunt in Southwest Unit 20D if ADF&G determines the moose population can support additional antlerless harvest and feels the harvest could be of benefit to the Unit 20D moose population. We recommend additional, conservative antlerless moose harvest in Southwest Unit 20D as long as the cumulative maximum harvest of moose (excluding ceremonial harvest) does not exceed 5% of the population.

The Delta Area needs to improve monitoring and documenting ceremonial harvest of moose in Unit 20D. Delta Area DWC staff should increase coordination with the Region III office to ensure ceremonial harvest reports are received and made available to the Delta Area Wildlife Biologist.

Moose in Southwest Unit 20D live proximate to domestic, and including nontraditional (e.g., elk), livestock in the Delta Junction area. In addition, some livestock from the Delta Junction area become feral or escape for periods of time within Unit 20D. Livestock pose potential health risks to moose due to the potential for transmission of pathogens and endo- and ectoparasites that are harmful to moose. ADF&G has no control over domestic livestock health and limited control over the consequences of contact between moose and livestock. Monitoring the health of moose in Unit 20D is an essential part of understanding potential health risks to the entire moose population of Alaska. Opportunistic and targeted health surveillance should be a standard part of moose management in Unit 20D.

The following are moose management recommendations for Unit 20D:

- Continue GSPE surveys in SW Unit 20D a minimum of 4 out of 5 years in order to monitor and evaluate trends in abundance, productivity, recruitment, and bull escapement.
- Continue evaluation of trends in the moose population's productivity (calves:100 cows), and sustainable bull harvests (bulls:100 cows) in SW Unit 20D a minimum of 4 out of 5 years.
- Continue GSPE surveys in the entire southern Unit 20D a minimum of 3 out of 5 years in order to monitor and evaluate trends in abundance, productivity, recruitment, and bull escapement.
- Continue evaluation of trends in the moose population's productivity (calves:100 cows), and sustainable bull harvests (bulls:100 cows) in the entire southern Unit 20D a minimum of 3 out of 5 years.
- Continue GSPE surveys in northern Unit 20D a minimum of once every 4 years in order to monitor and evaluate trends in abundance, productivity, recruitment, and bull escapement.
- Continue evaluation of trends in the moose population's productivity (calves:100 cows), and sustainable bull harvests (bulls:100 cows) in northern Unit 20D a minimum of once every 4 years.
- Incorporate SCF trials into GSPEs once every 5 years for southern/SW Unit 20D and once every 8 years for northern Unit 20D to improve population estimate and trend.
- Continue spring twinning rate surveys to determine trend in this measurement of population status.
- Manage for zero population growth.
- Initiate a small-scale antlerless moose hunt in southwest Unit 20D to contribute to maintaining a stable moose population and zero population growth.
- Continue to monitor total harvest for comparison with the IM harvest objective.
- Modify comparisons of reported harvest to the lower threshold of the IM harvest objective using 3-year running means to account for annual variability.
- Prepare a proposal for the next BOG cycle to adjust the IM population and harvest objectives to sustainable levels.
- Place emphasis on documentation of ceremonial harvest of moose including coordination with the Region III office and soliciting reports from ceremonial harvest permit holders.
- Periodically capture and compare mass of short-yearlings with short-yearlings weighed in 2010 and 2012 to substantiate low twinning-based nutritional status.
- Periodically capture short-yearlings in portions of northern Unit 20D if population continues to expand to ensure calves are not nutritionally stressed in this area.

- Conduct survey on biomass removal of current annual growth on winter browse (Paragi et al. 2008) a minimum of once out of every 4 years.
- Assess areas in southwestern Unit 20D for mechanical and/or prescribed fire disturbance of vegetation that has grown beyond a productive state for moose and improve the availability and nutritional value of winter forage.
- Conduct opportunistic and targeted health surveillance in Unit 20D moose, with emphasis placed on moose from southwestern Unit 20D.
- Work with the U.S. Army Fort Wainwright to mitigate conflicts between training and fall hunting seasons for moose, caribou (*Rangifer tarandus*), and Dall sheep (*Ovis dalli*).
- Work with the U.S. Army Fort Greely to address concerns about the presence of moose on Allen Army Airfield in regards to safety for military personnel, protection of military aircraft, and the welfare of moose that are trapped within the perimeter fence of Allen Army Airfield.
- Work with the U.S. Army Fort Greely to address concerns about restriction of moose ingress and egress on Fort Greely lands.

II. Project Review and RY15–RY19 Plan

Review of Management Direction

MANAGEMENT DIRECTION

GOALS

- G1. Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- G2. Provide the greatest sustained opportunity to participate in hunting moose.
- G3. Provide an opportunity to view and photograph moose.

CODIFIED OBJECTIVES

Amount Reasonably Necessary for Subsistence Uses

The following portions of Unit 20D have customary and traditional use findings for moose, with amounts reasonably necessary for opportunity for subsistence uses (ANS) as follows:

- C1. ANS of 5–15 moose in Unit 20D, that portion north of the Tanana River and outside the boundaries of the Fairbanks Nonsubsistence Area.
- C2. ANS of 5 moose in Unit 20D, that portion south of the Tanana River.

Intensive Management

- C3. Population objective: 8,000–10,000 moose.
- C4. Harvest objective: 500–700 moose.

MANAGEMENT OBJECTIVES

- M1. Increase the fall moose population to 8,000–10,000 moose with an annual reported sustainable harvest of 500–700 moose per year.
- M2. Manage the northern and southern Unit 20D moose populations independently (north and south of the Tanana River) for optimal population size based on indices to density-dependent nutritional limitation, to guard against eventual site-specific long-term range damage and starvation from overabundance.
- M3. Manage population levels based on multi-year mean spring twinning rates in conjunction with at least one of the following signals to substantiate low twinning-based nutritional status: <50% of 36-month-old moose are parturient, average multi-year short-yearling mass is <385 lb (175 kg), or >35% of annual browse biomass is removed by moose (Boertje et al. 2007):
 - a. Manage to increase the population when the average 2-year prior twinning rate exceeds 20% but adjust to a reduced rate of increase as this twinning rate average approaches 20%.
 - b. Manage for a stable population size when the 2-year prior twinning rate averages 11–20%.
 - c. Manage to decrease the population when the 2-year prior twinning rate averages $\leq 10\%$.
- M4. Harvest the northern and southern Unit 20D moose population (north and south of the Tanana River) independently. The bull segment of the population will be managed in any portion of Unit 20D for sustainable harvest to take the maximum number of bulls.
- M5. The bull bag limit will be liberal for any significant portion of Unit 20D with a ratio of ≥ 30 bulls:100 cows for ≥ 2 consecutive years. If, in any portion, the bull:cow ratio decreases to <30 bulls:100 cows for ≥ 2 consecutive years, regulations will be adopted to restrict bull harvest sufficient to maintain a ratio of >20 bulls:100 cows.
- M6. Antlerless moose harvest will be implemented as needed to manage for increasing population growth, no growth, or decreasing population growth as described in the population objective. Significant antlerless harvest will not be implemented on a declining population when the 2-year prior twinning rate averages >20%, but allowing minimal ($n \leq 16$) antlerless harvest as part of youth or disabled veterans hunts will be evaluated and considered.

REVIEW OF MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Geospatial population estimation (GSPE) surveys. (objectives C1, C2, C3, M1, M2, M5)

Data Needs

Unit 20D was identified by BOG for IM of moose with a population objective of 8,000–10,000 moose. Population status and trends are integral components of management and GSPEs the preferred technique for this application (i.e., estimates at the Unit 20D-scale).

- Annual abundance (annual population estimates, 90% CI \pm 14–20%), productivity (i.e., calf:cow ratios – 90% CI \pm 20–30%) and survival/escapement (bull:cow ratios – 90% CI \pm 15–25%) to evaluate status and trend.

Methods

- GSPE with periodic SCF trials (see “I. RY10–RY14 Management Report | 1. Population Status and Trend | Methods” this document; Kellie and DeLong 2006).
 - Maintain 70 high:30 low density SU ratio.
 - Abundance estimates (90% CI) compared to the lower limit of the ANS and IM population objective.
 - Biometric review:
 - Estimate the abundance of moose using GSPE with an SCF such that a 90% CI has bounds between 14% and 20%. Biometrician and biologist to review the ability to achieve the level of precision before surveys.
- Composition estimates:
 - Evaluate bull:cow ratio estimates (90% CI) in relation to the lower limit of the bull:cow ratio management objective.
 - Biometric review:
 - Estimate bull:cow and calf:cow ratios and construct 90% CI using GSPE.
 - Review the historical precision of the surveys and determine the precision necessary to compare survey results to the objective.

ACTIVITY 1.2. Spring twinning surveys. (objectives C2, M3)

Data Needs

Estimates of the moose population’s nutritional condition and productivity are integral to management on a sustained yield basis over the long term and twinning rates are an index of density-dependent moose nutritional condition.

Methods

See “I. RY10–RY14 Management Report | 1. Population Status and Trend | Activity 1.2. Spring twinning surveys | Methods” this document.

- Compare multi-year mean unitwide twinning rates to twinning rate categories in management objective M3.
- Biometric review:
 - Estimate twinning rates and construct 95% CI. Review the historical precision of the surveys and then determine the precision necessary to compare survey results to the objective.

ACTIVITY 1.C. Short-yearling mass estimates. (objectives C2, M1)

Data Needs

Unit 20D was identified by BOG for IM of moose. Estimates of the moose population’s nutritional condition are integral to management on a sustained yield basis over the long term.

Methods

Periodically capture and compare mass of short-yearlings with short-yearlings weighed in 2010 and 2012 (K. A. K. Seaton, ADF&G, unpublished data, Fairbanks) and to the 385 lb threshold identified to substantiate low twinning-based nutritional status (Boertje et al. 2007). Multi-year samples (2015–2016) are desired to incorporate annual variation in short-yearling weights resulting from differences in environmental conditions (e.g., weather, snow conditions, etc.).

- Biometric review:
 - Estimate the mean mass and test differences between pre- and posttreatment using analysis of variance (ANOVA). Biologist and biometrician to determine what difference in short-yearling mass is biologically significant and the statistical power needed to detect that change for the next survey.

2. Mortality–Harvest Monitoring

ACTIVITY 2.1. Monitor and analyze harvest data. (objectives C3, M1, M4)

Data Needs

Unit 20D was identified by BOG for IM of moose with a harvest objective of 500–700 moose annually.

Methods

- Monitor total harvest for comparisons with the IM harvest objective (see “I. RY10–RY14 Management Report | 2. Mortality–Harvest Monitoring and Regulations | Methods” this document).

- Compare reported harvest, using 3-year running means to account for annual variation in harvest, to the lower limit of the IM harvest objective.
- Biometric review:
 - We may need to review management or research questions about harvests (hunter behavior or population monitoring) that are meaningful to include in management reports and for decisions. Biometrician to review the harvest card procedures, consistency of data, and independence issues for analysis.

3. Habitat Assessment–Enhancement

ACTIVITY 3.1. Enhance availability and nutritional value of moose forage. (objectives C2, M1)

Data Needs

Unit 20D was identified by BOG for IM of moose with a population objective of 8,000–10,000 moose.

Methods

- Assess areas in southwestern Unit 20D for mechanical and/or prescribed fire disturbance of vegetation that has grown beyond a productive state for moose and improve the availability and nutritional value of winter forage.
- Make contact and begin working with DWC’s habitat technical experts and the Department of Natural Resources–Division of Forestry by 30 June 2017 to identify and assess potential treatment areas, determine feasibility of conducting treatments, and securing any necessary permissions and permits.
- The years and the size of treatments cannot be determined until the amount of available funding is known.
- Conduct surveys on biomass removal of current annual growth on winter browse (Paragi et al. 2008) a minimum of once every 4 years.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

- Conduct opportunistic and targeted health surveillance in Unit 20D moose, with emphasis placed on moose from southwestern Unit 20D. Sample moose carcasses to test for presence of chronic wasting disease, meningeal worm, Johne’s disease, brucellosis, *Mycoplasma* spp., and adenovirus. Conduct opportunistic inspections of moose carcasses for ectoparasites; if ectoparasites are found, collect them for submittal to laboratory for identification.
- Work with the U.S. Army Fort Wainwright to mitigate conflicts between training and fall hunting seasons for moose, caribou and sheep.
- Work with the U.S. Army Fort Greely to address concerns about the presence of moose on Allen Army Airfield in regards to safety for military personnel, protection of military

aircraft, and the welfare of moose that are trapped within the perimeter fence of Allen Army Airfield.

- Work with the U.S. Army Fort Greely to address concerns about restriction of moose ingress and egress on Fort Greely lands.
- High tensile game fences and other fences on the Delta Agricultural Project (east of Delta Junction) are impediments to daily and seasonal moose movements, cause moose injuries and mortalities, and bring about separation of dams and calves. The number of fencelines and fenced parcels of land on the Delta Agricultural Project has increased significantly since 2014. The ADF&G Delta Area office will provide technical guidance to landowners and agencies that work with landowners (i.e., Delta Soil and Water Conservation District; U.S. Department of Agriculture–Natural Resources Conservation Service) in fence design and gate locations to mitigate negative impacts of fences to moose.

Data Recording and Archiving

RECORDING

- Capture data will be entered into the moose database on the WinfoNet server. Field data sheets will be stored in a file cabinet in the Delta Area Biologist's office at ADF&G's Delta Area office (MP 266.8, Richardson Highway, Delta Junction, Alaska).

ARCHIVING

- Harvest and GSPE data will be stored on an internal database housed on the WinfoNet server (<http://winfonet.alaska.gov/index.cfm>). GSPE field data sheets will be stored in a file cabinet in the Delta Area Biologist's office in ADF&G's Delta Area office (MP 267, Richardson Highway, Delta Junction, Alaska).
- All other electronic data will be located on the computer in the Delta Area Biologist's office in ADF&G's Delta Area office. Field data sheets, paper files, hard copies, etc. will be located in a file cabinet located in the Delta Area Biologist's office and archived on WinfoNet – Data Archive, Project Title: Moose Management Program Unit 20D. Project ID: Unit 20D Moose. Primary Region: Region III

Agreements

- U.S. Army Fort Wainwright Cooperative Agreement dated 30 June 2012.

Permitting

- None

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