Species Management Report and Plan ADF&G/DWC/SMR&P–2018–5

Moose Management Report and Plan, Game Management Unit 21D:

Report Period 1 July 2010–30 June 2015, and

Plan Period 1 July 2015–30 June 2020

Glenn W. Stout

2018

Alaska Department of Fish and Game Division of Wildlife Conservation

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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 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 Doreen I. Parker McNeill, 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 21D for the previous 5 regulatory years and plans for survey and inventory management activities in the 5 years following the end of that period. 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 them of wildlife management activities. In 2016 the Alaska Department of Fish and Game's (ADF&G) Division of Wildlife Conservation 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). The goals and objectives in this moose report supersede those of any historical plans or management reports for Unit 21D.

I. RY10–RY14 Management Report

Management Area

Unit 21D (12,093.6 mi^2) is located in western Interior Alaska and encompasses the Koyukuk River drainage upstream of the Dulbi River drainage. Portions of 4 ecoregions found in Unit 21D include the Nulato Hills, Ray Mountains, Kuskokwim Mountains, and Yukon River lowlands ecoregions (Nowacki et al. 2001). Maps for Unit 21D boundaries and special management areas are found at http://www.adfg.alaska.gov/index.cfm?adfg=maps.main.

Summary of Status, Trend, Management Activities, and History of Moose in Unit 21D

Moose are abundant in much of Unit 21D. Local residents first reported seeing occasional moose tracks during winters in the 1930s. During the 1940s and early 1950s, numbers of moose and wolves (*Canis lupus*) slowly increased (Huntington 1993). During the 1950s, federal wolf control and aerial shooting reduced the wolf population allowing a rapid expansion of the moose population during the late 1950s and on through the 1960s. Expansion may have begun slowing in 1959 when statehood brought an end to federal wolf control. The moose population reached peak numbers about 1970 (S. Huntington, personal communication to T. Osborne, Wildlife Biologist, ADF&G, Galena) and then stabilized or declined slightly in localized areas in response to increased predation and hunting pressure. Increased predation may have been related to passage of the federal Airborne Hunting Act in 1972, which halted aerial shooting of predators by the public (Regelin et al. 2005).

Moose trend count areas (TCA) established in 1981 in the floodplain areas of the lower Koyukuk and Yukon rivers indicated generally increasing moose densities through about 1993 (Stout 2008). Initially, we thought this was due to better surveys, but a population estimation survey of the Kaiyuh Flats and the lower Koyukuk River in 1987 corroborated TCA data (Osborne 1996). Moose densities were high along the Yukon River floodplain (3–6 moose/mi^2) and were very

high on the Koyukuk River in the Three Day Slough TCA where densities reached 13.3 moose/mi^2 in early winter 1993 (Stout 2008). We estimated that 6,340 moose inhabited the portion of Unit 21D where most moose are found in the best habitat of the area, and extrapolation of the data to the remainder of Unit 21D suggested a unitwide population of 9,000–10,000 in 1993.

A population estimation survey in fall 1997 in the lower Koyukuk drainage and the Kaiyuh Flats indicated moose numbers were similar to the 1993 estimate (Huntington 1998). However, a population estimation survey in 2001 suggested the population had declined marginally to 8,500–9,500 moose by winter 2001–2002, which seemed to be corroborated by declining recruitment parameters observed in the TCAs during 1997–2001. Since 2001 there were fluctuations in the abundance of moose due to stochastic changes in productivity and survival, but no clear trend in the recent trajectory of the population is apparent.

Residents of the 4 villages within Unit 21D (Kaltag, Nulato, Koyukuk, and Galena) and the village (Ruby) in Unit 21B near the boundary with Unit 21D have traditional hunting areas within Unit 21D. Those local residents often traveled as much as 100 miles up the Koyukuk River in the 1980s–2000s until fuel prices began to restrict travel in the 2000s–2010s. Nonlocal hunters using Unit 21D mostly concentrated their hunting activities within the Koyukuk River between the Kateel River and Dulbi Slough. Hunting pressure from nonlocal hunters appeared to be gradually shifting farther upriver as hunters from outside the unit learned the logistics of accessing the area.

The Koyukuk controlled use area (CUA) was established in 1978 and prohibits the use of aircraft for moose hunting in the area; therefore, most moose hunters access the area by boat. The Koyukuk CUA occupies 4,791 mi^2 in northern Unit 21D and southern Unit 24 and overlaps with a large portion of the Koyukuk National Wildlife Refuge. Since 1983 the department has operated a hunter checkstation on the Koyukuk River, 15 miles upstream from the village of Koyukuk. In 1990 the Koyukuk River checkstation became a mandatory stop for all hunters. The checkstation enables accurate determination of the number of hunters using the river to access the Koyukuk CUA within Unit 21D during the fall hunting season. It is also used to collect biological data from harvested animals, educate local residents concerning licensing and reporting requirements, and to inform nonlocal hunters about regulations specific to the area and locations of private property near the river.

The fall hunting season dates changed several times during 1975–1981. In 1981–1996 there was a 21-day fall season for the entire unit. Harvest of cows was allowed during the last 5 days. A 10-day season in early March also provided hunting opportunity for Alaska residents. In 1991 nonresidents were restricted to bulls with an antler spread of ≥50 inches or at least 3 brow tines on one side. In 1992 the minimum number of brow tines on one side was increased to 4. Also beginning in 1992, meat of the hindquarters, forequarters, and ribs of any moose taken in the Koyukuk CUA had to remain on the bone. In 1996, due to increasing moose hunter numbers and moose harvest, subsistence and general registration hunts were established for the Koyukuk CUA downstream from Huslia. In 2000, resident and nonresident drawing hunts were added. By 2006, all of Unit 21D was managed through subsistence registration hunts with antler destruction disincentives or limited drawing permit hunts.

Management Direction

EXISTING WILDLIFE MANAGEMENT PLANS

The *Koyukuk River Moose Management Plan 2000-2005: Unit 24 and the northern portion of Unit 21D* was published in March 2001 and is still active (Koyukuk River Moose Hunters Working Group 2001). This plan identified predation on moose as significant and increasing. It stipulated an objective to provide for increased harvest of predators of moose (including wolves) and a recommendation to implement aerial wolf control to make progress toward intensive management objectives for moose abundance and harvest.

Direction for the management of the remainder of Unit 21D has been reviewed and modified through public comments, staff recommendations, and Board of Game actions over the years. A record of these changes can be found in the division's management report series. The plan portion of this report contains the current management plan for moose in Unit 21D.

GOALS

- Manage Koyukuk River drainage moose on a sustained yield basis to provide both hunting and other enjoyment of wildlife in a manner that complements the wild and remote character of the area and minimizes disruption of local residents' lifestyles.
- Protect and enhance moose habitat.
- Reduce meat spoilage by hunters.
- Maintain opportunities for wildlife viewing, photography, and other nonconsumptive uses of wildlife within the Koyukuk River drainage.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

Unit 21 has a positive finding for customary and traditional uses for moose and amounts reasonably necessary for subsistence uses of 600–800 moose from the unitwide population on an annual basis.

Intensive Management

Unit	Population objective	Harvest objective
21D	7,000–10,000 moose	450–1,000

MANAGEMENT OBJECTIVES

1. Maintain a moose population of 9,000–10,000 observable moose.

2. Provide for a harvest of moose not to exceed 700 moose or 7% of the annual moose population estimate each regulatory year.
3. Provide for moose hunting opportunity not to exceed 950 hunters per regulatory year.
4. Maintain an overall meat assessment score of less than "3" for ≤5% of the hunters each regulatory year.

MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Conduct trend count surveys annually or population estimation surveys when funding is available.

Data Needs

A statistical estimate of the moose population is needed to evaluate the status of the population and determine whether the objective to maintain a fall population of 9,000–10,000 moose was achieved. A statistical estimate of the moose population derived from geospatial population estimator (GSPE), including a measure of the precision, is needed to detect change in the population. Where a GSPE cannot be conducted regularly enough to monitor population trend, trend count surveys will be conducted to monitor change in calf:cow, yearling bull:cow, and total bull:cow ratios. Calf:cow and yearling bull:cow ratios will assess productivity and recruitment, and total bull:cow ratios will assess harvest effects on the population.

Twinning surveys need to be conducted to collect twinning rate data which serve as indicators for body condition and productivity of cows. An assessment of body condition and productivity is integral to management on a sustained yield basis for the long-term and for the goal of protecting moose habitat.

Methods

Population Size

Beginning in 1999, we conducted population estimation surveys and analyzed data using GSPE (Ver Hoef 2001, 2008; Kellie and DeLong 2006). GSPE surveys since 1999 were conducted according to methods and in areas described in Stout (2010).

No new population estimation surveys were completed in Unit 21D since the 2012 management report (Stout 2012a).

The regulatory year moose population estimate is based on previously reported values (Stout 2012a), RY10–RY15 trend count surveys, and RY10–RY11 GSPE surveys. I developed the RY14 moose population estimate for Unit 21D by individually estimating moose densities in each of the 6 drawing permit hunt areas within Unit 21D. To accomplish this, I used data from the 2001, 2004, 2010, and 2011 GSPE surveys as well as fall 2004–2015 TCA data (Stout 2010). For those areas that did not have survey data, I used recent density estimates from GSPE surveys in similar habitat within Unit 21D. Therefore, to varying degrees, estimates for each permit area were a combination of GSPE survey data, trend count survey data, and extrapolated data. I

included range approximations for population estimates to indicate uncertainty in the estimate. Range approximations were variable based on knowledge of the area. Values that include a 90% confidence interval (CI) were statistically derived variances. However, values followed by a (±) symbol that do not have a 90% CI designation were based on knowledge of the area and previously conducted surveys.

Population Composition

Composition data included results of GSPE surveys and TCA surveys. Moose in 6 TCAs (Dulbi River mouth, Three Day Slough, Koyukuk mouth, Pilot Mountain, Squirrel Creek, and Kaiyuh Slough) were classified as cows, calves, yearling bulls (<30″ antler width and no brow tine definition), medium bulls (≥30″ and <50″ antler width), or large bulls (≥50″ antler width) using methods previously described (Stout 2010). TCA surveys were not assessed in RY12 due to poor survey conditions. These surveys were conducted in cooperation with staff from the Koyukuk National Wildlife Refuge during RY10–RY15. Assessment of the Koyukuk CUA bull:cow ratio was completed by combining the data from the Koyukuk mouth, Three Day Slough, and Dulbi River mouth TCAs in Unit 21D with the Huslia Flats and Treat Island TCAs from Unit 24D (Stout 2014). These 5 TCAs were considered the "Core-5 TCAs" for assessing the Koyukuk moose management plan objective to maintain 30 bulls:100 cows.

Guidelines reported by Franzmann and Schwartz (1998) were used to interpret sex and age indices as reported in Stout (2010).

Spring Twinning Surveys

Beginning in 1990, twinning surveys were conducted to determine the proportion of moose calf twins among all cows with calves in the areas of Three Day Slough/Dulbi River mouth, Kaiyuh Flats/Pilot Mountain Slough, and Natlaratlen River/Bear Creek. Aerial twinning surveys consisted of parallel transects flown at approximately ¼-mile intervals at ≤500 feet above ground level in a PA-18 or similar aircraft by experienced pilots. Our goal was to observe at least 50 cows with calves (Boertje et al. 2007) in each area, but funding and weather sometimes prevented us from achieving that goal. Moose were classified as bull, yearling, calf, cow, cow with 1 calf, or cow with 2 or more calves. Timing was critical, so surveys were flown in late May within a few days of the median calving date (Boertje et al. 2007), when approximately 50% of the cows observed had calves. This avoided early mortality factors such as predation, which could lead to underestimating twinning rates. Twinning rate was calculated as the proportion of cows with more than 1 calf from a sample of all cows with calves. In Unit 21D an assessment of annual calf productivity and potential mortality factors was completed using spring twinning rates, reported parturition rates (Boertje et al. 2007), and fall calf:100 cow ratios. These surveys were conducted in cooperation with staff from the Koyukuk National Wildlife Refuge during RY10–RY15, except for RY12 due to the Galena flood.

Results and Discussion

Population Size

Overall, the moose population trend counts during RY10–RY14 showed a generally stable index to abundance in Unit 21D over recent years (Tables 1–7) as previously described (Stout 2010).

Density estimates in the western Galena GSPE analysis area of Unit 21D also indicated a stable trend through 2011 (Table 8).

In 2010 we classified 769 moose during the GSPE survey (covering 3,516 mi^2 in the upper Bear Creek and upper Dulbi River drainages). In the 2011 GSPE survey (which overlapped survey areas sampled in RY01 and RY04) we classified 5,620 moose. The population estimate for the total survey block calculated from the 2011 survey was not significantly different (95% CI) from the 2001 or 2004 estimates; however, the 2011 point estimate was lower than 2001 and 2004. By combining estimates for individual drawing hunt areas in Unit 21D, I estimated a Unit 21D population of 8,611 observable moose in RY11 (Table 9). This estimate changed to 8,749 for RY14 due to calculation corrections, but no GSPE surveys were conducted since RY11 to indicate an actual change in the population.

Population Composition

From the 2011 GSPE survey, we calculated 28 calves:100 cows, which is within the range (20–40 calves:100 cows) reported by Franzmann and Schwartz (1998) for maintaining a stable or increasing population. TCA surveys were not conducted in RY12 due to poor survey conditions. Most TCAs had moderate calf:cow ratios during RY10–RY14, but very high calf:cow ratios in RY15.

The 2011 GSPE survey data indicated 32 bulls:100 cows, well above the minimum needed for adequate productivity. TCA data during RY10–RY15 also indicated relatively stable bull:cow ratios; however, yearling bull:cow ratios were low in some areas. Bull:cow ratios continue to vary widely among TCAs (Tables 1–7). Total moose counted in the Three Day Slough and Dulbi River mouth TCAs declined during RY10–RY14. Koyukuk mouth, Squirrel Creek, and Pilot Mountain TCAs indicated mostly stable parameters through RY14, but calf counts increased in RY15. The Koyukuk CUA Core-5 TCAs dropped below 30 bulls:100 cows in RY13 and RY15, likely due to the poor cohorts of 2008 and 2009. Only in the Kaiyuh Slough TCA were calf:cow and yearling bull:cow ratios consistently high and stable during RY10–RY15.

Moose twinning rates during RY10–RY15 (4-year $\bar{x}$ = 33% Three Day Slough/Dulbi River mouth, 37% Pilot Mountain/Kaiyuh Flats, 34% Natlaratlen River/Bear Creek) suggest above average nutritional status (Boertje et al. 2007) and productivity in those areas of Unit 21D (Tables 10–12).

Recommendations for Activity 1.1.

Specify a GSPE population estimate objective for only the western Galena and Kaiyuh Flats subareas in Unit 21D (Table 8). Specify that population estimation activities will be conducted in the western Galena and Kaiyuh Flats subareas by conducting in a high intensity GSPE survey once every 5 years and at least 2 low intensity GSPE surveys during a 5-year period. A specific GSPE population estimate will be used to evaluate the population management objectives without the uncertainty of interpretation caused by extrapolated estimates and will improve our ability to calculate harvestable surplus in the areas of highest harvest. Using the 2001 GSPE point estimate for those 2 areas combined, establish an initial objective of 5,200 moose. Continue TCA surveys annually to evaluate abundance productivity, survival, recruitment, and sex ratios. Utilize memos to archive details of surveys and keep management reports concise.

Table 1. Unit 21D Three Day Slough trend count area aerial moose composition counts, Interior Alaska, regulatory years[a] 2010–2015[b].

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins:100 Cows with calves	Percent calves	Moose	Moose/mi^2
2010	193.6	31	4	26	3	17	1,148	5.9
2011	193.6	31	11	23	5	15	921	4.8
2013	193.6	21	4	17	3	12	794	4.1
2014	193.6	21	8	17	4	13	758	3.9
2015	193.6	20	8	36	8	23	801	4.1

[a] Regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011).
[b] Beginning in RY01, geospatial population estimator sample units replaced Gasaway units (Stout 2004).

Table 2. Unit 21D Dulbi River mouth trend count area aerial moose composition counts, Interior Alaska, regulatory years[a] 2010–2015[b,c].

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
2010	116.7	24	2	32	8	19	414	3.6
2011	111.1	24	7	29	3	19	506	4.4
2013	111.1	25	7	13	0	10	365	3.3
2014	111.1	39	10	30	3	18	211	1.9
2015	111.1	21	6	47	14	28	450	4.1

[a] Regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011).
[b] Beginning in RY01, geospatial population estimator sample units replaced Gasaway units (Stout 2004).
[c] Data collected by U.S. Fish and Wildlife Service.

Table 3. Unit 21D Koyukuk River mouth aerial moose composition counts, Interior Alaska, regulatory years[a] 2010–2015[b,c].

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
2010	118.8	23	3	27	10	18	493	4.2
2011	118.8	20	5	24	1	17	503	4.2
2013	118.8	23	9	11	0	8	450	3.8
2014	118.8	23	6	33	11	21	420	3.5
2015	118.8	23	12	41	14	25	607	5.1

[a] Regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011).
[b] Beginning in RY01, geospatial population estimator sample units replaced Gasaway units (Stout 2004).
[c] Data collected by U.S. Fish and Wildlife Service.

Table 4. Unit 21D Squirrel Creek aerial moose composition counts, Interior Alaska, regulatory years[a] 2010–2015[b,c].

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
2010	90.9	25	5	42	18	25	289	3.2
2011	96.6	24	7	37	12	23	288	3.0
2013	96.6	39	11	30	3	18	205	2.1
2014	90.9	38	14	60	22	31	259	2.8
2015	90.9	47	21	52	15	26	382	4.2

[a] Regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011).
[b] Beginning in RY01, geospatial population estimator sample units replaced Gasaway units (Stout 2004).
[c] Data collected by U.S. Fish and Wildlife Service.

Table 5. Unit 21D Pilot Mountain Slough aerial moose composition counts, Interior Alaska, regulatory years[a] 2010–2015[b,c].

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
2010	91.0	17	2	48	5	29	466	5.1
2011	91.0	18	9	30	9	25	563	6.2
2013	91.0	23	8	23	12	16	472	5.2
2014	91.0	18	5	46	12	28	491	5.4
2015	91.0	15	8	62	16	35	656	7.2

[a] Regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011).
[b] Beginning in RY01, geospatial population estimator sample units replaced Gasaway units (Stout 2004).
[c] Data collected by U.S. Fish and Wildlife Service.

Table 6. Unit 21D Kaiyuh Slough aerial moose composition counts, Interior Alaska, regulatory years[a] 2010–2015[b,c].

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
2010	126.3	44	11	52	9	26	190	1.5
2011	126.3	45	19	56	20	28	261	2.1
2013	126.3	51	19	43	15	22	274	2.2
2014	126.3	60	15	69	17	30	232	1.8
2015	126.3	41	18	60	17	30	355	2.8

[a] Regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011).
[b] Beginning in RY01, geospatial population estimator sample units replaced Gasaway units (Stout 2004).
[c] Data collected by U.S. Fish and Wildlife Service.

Table 7. Unit 21D and Unit 24D[a], Koyukuk controlled use area Core-5 aerial moose composition counts combined results, Interior Alaska, regulatory years[b] 2010–2015[c,d].

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Twins:100 Cows with calves	Percent calves	Moose	Moose/mi^2
2010	734.5	31	5	26	5	17	3,355	4.6
2011	729.1	30	9	23	3	15	3,187	4.4
2013	712.6	25	6	16	2	12	2,538	3.6
2014	712.6	30	8	21	6	14	2,246	3.2
2015	712.6	26	9	39	12	24	3,039	4.3

[a] Unit 24D data (Stout, *In prep*).
[b] Regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011).
[c] Beginning in RY01, geospatial population estimator sample units replaced Gasaway units (Stout 2004).
[d] Data collected by ADF&G and U.S. Fish and Wildlife Service.

Table 8. Unit 21D aerial moose population estimates, Interior Alaska, regulatory years[a] 1987–2011.

Area/Regulatory year	Area mi^2	Bulls:100 cows	Calves:100 cows	Yrlg bulls:100 cows	Percent calves	Adults	Population estimate (90% CI[b])	Density (moose/mi^2)
Unit 21D–Kaiyuh Flats								
1987[c]	1,582	60.6	46.4	15.0	22.4	1,389	1,790±18%	1.13
1997[d]	1,582	42.3	28.4	13.0	16.6	1,113	1,335±17%	0.84
2001[e]	1,843	44.5	22.1	8.8	13.4	1,558	1,800±32%	0.98
2004[e]	1,843	35.1	43.3	12.2	24.7	1,119	1,487±10%	0.81
2011[e]	1,843	30.5	38.6	10.4	22.9	1,463	1,897±11%	1.03
Unit 21D–Western Galena								
1987[c]	1,508	36.7	38.2	12.4	21.8	3,220	4,118±14%	2.73
1997[d]	1,508	31.3	32.1	8.0	19.6	2,612	3,250±12%	2.15
2001[e]	1,734	26.6	17.1	6.4	12.0	2,995	3,403±19%	1.96
2004[e]	1,841	26.2	36.2	10.5	22.3	2,564	3,299±5%	1.79
2011[e]	1,841	29.0	25.0	8.8	16.3	2,811	3,360±7%	1.83
Unit 21D–Yuki River–Bear Creek								
2010[e]	3,516	64.3	27.4	9.9	14.5	1,477	1,727±14%	0.49
Unit 24D–Upper Koyukuk								
2001[e]	1,949	35.0	17.6	6.1	11.4	3,228	3,642±16%	1.87
2004[e]	1,843	32.7	33.9	12.6	20.4	2,531	3,181±5%	1.73
2011[e]	1,843	38.4	23.4	9.2	14.4	2,249	2,627±8%	1.43
Total Area								
1987[c]	3,090	43.1	40.4	13.1	6.7	4,609	5,908±15%	1.91
1997[d]	3,090	34.4	31.1	9.4	17.8	3,725	4,585±14%	1.48
2001[e]	5,526	33.4	18.3	6.7	12.0	7,849	8,924±13%	1.62
2004[e]	5,527	30.4	36.5	11.6	18.2	6,514	7,967±4%	1.44
2011[e]	5,527	32.4	27.6	9.3	17.3	6,524	7,885±4%	1.43

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 1987 = 1 July 1987–30 June 1988).
[b] CI = confidence interval.
[c] Gasaway survey, MOOSEPOP analysis estimate (Woolington 1998) with sightability correction factor.
[d] Gasaway survey, regression analysis estimate, with sightability correction factor.
[e] Geospatial population estimation survey without sightability correction factor.

Table 9. Unit 21D moose population estimate by drawing hunt areas, Interior Alaska, regulatory year[a] 2014[b].

Drawing hunt area	Density estimate	Moose estimate
(DM816) Yuki River and Bishop Creek	(545 mi^2 @ 1.44 moose/mi^2)	785
	(1,555 mi^2 @ 0.37 moose/mi^2)	575
	Subtotal	1,360
(DM817) Nulato River and Kaiyuh Flats	(612 mi^2 @ 1.03 moose/mi^2)	630
	(2,329 mi^2 @ 0.46 moose/mi^2)	1,071
	Subtotal	1,701
(DM818) Papa Willie Slough	(360 mi^2 @ 1.30 moose/mi^2)	468
	(1,096 mi^2 @ 0.35 moose/mi^2)	383
	Subtotal	851
(DM823–DM830) Koyukuk Controlled Use Area	(1,929 mi^2 @ 1.83 moose/mi^2)	3,530
	(468.6 mi^2 @ 0.35 moose/mi^2)	164
	Subtotal	3,694
(DM814, DM815, DM819) Bear Creek	(916 mi^2 @ 0.75 moose/mi^2)	687
(DM820) Gisasa and Kateel rivers	(2,283 mi^2 @ 0.20 moose/mi^2)	456
Unit 21D total	(12,093.6 mi^2)	8,749 (±1,300)[c]

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2014 = 1 July 2014–30 June 2015).
[b] Population estimates for each permit area were a combination of population estimation survey data, trend count survey data, and extrapolation data to varying degrees.
[c] The range on the estimate is not a statistically derived confidence interval. The 15% relative error of ±1,300 moose is a presumed level of uncertainty with no empirical basis.

Table 10. Unit 21D moose aerial twinning surveys in the Three Day Slough trend count area, Interior Alaska, regulatory years[a] 2010–2014.

Regulatory year	Cows w/o calves	Cows w/1 calf	Cows w/twins	Twinning %[b]	Yearlings	Dates in May
2010	59	33	17	34	34	25–27
2011	74	39	19	33	28	26–28
2013	46	57	12	17	18	30, 31
2014	55	27	24	47	14	25, 26

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Percent of cows with calves that had 2 or more calves.

Table 11. Unit 21D moose aerial twinning surveys in the Pilot Mountain Slough to Kaiyuh Flats areas, Interior Alaska, regulatory years[a] 2010–2014[b].

Regulatory year	Cows w/o calves	Cows w/1 calf	Cows w/twins	Twinning %[c]	Yearlings	Dates in May
2010	50	39	17	30	13	27
2011	94	30	21	41	13	24–26, 29
2013	59	29	24	45	13	26–28
2014	39	42	19	31	32	25, 26

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Data collected by U.S. Fish and Wildlife Service.
[c] Percent of cows with calves that had twins.

Table 12. Unit 21D moose aerial twinning surveys in the Natlaratlen River and Bear Creek area, Interior Alaska, regulatory years[a] 2010–2014[b].

Regulatory year	Cows w/o calves	Cows w/1 calf	Cows w/twins	Twinning %[c]	Yearlings	Dates in May
2010	91	34	19	36	19	26, 27
2011	124	41	18	31	8	24–26, 29
2013	70	32	20	38	15	26–28
2014	55	39	17	30	27	25–27

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Data collected by U.S. Fish and Wildlife Service.
[c] Percent of cows with calves that had twins.

Continue twinning surveys in Unit 21D annually and evaluate abundance, body condition, and productivity. Utilize memos to archive details of surveys and keep management reports concise. GSPE surveys, TCA surveys, and twinning surveys should be outlined as independent activities in the plan.

2. Mortality-Harvest Monitoring and Regulations

ACTIVITY 2.1. Monitor hunter use levels in the Koyukuk River drainage.

Data Needs

Harvest estimates are needed in order to establish that the population is not being harvested in excess of sustained yield in the Koyukuk River drainage portion of Unit 21D, because nearly 70% of the annual harvest occurs in that portion of the unit. Harvest data from a moose database in ADF&G's Wildlife Information Network (WinfoNet) are needed annually to assess trends in harvest. Moose harvested, harvest location, and hunter effort are critical elements needed to assess harvest trends and corroborate aerial survey observations.

Methods

Hunting mortality and harvest distribution were monitored through the statewide harvest monitoring system, including registration and drawing permit reports, door-to-door subsistence surveys, and a hunter checkstation on the Koyukuk River. Hunters with registration or drawing permits received 1 or 2 reminder letters and usually an e-mail and telephone calls if we did not receive timely harvest reports. Report and survey information were used to determine total harvest, harvest location, hunter residency and success, sex of animal harvested, method and location of harvest, harvest chronology, and transportation used. Harvest reports were collected from most hunters at the checkstation. Additional data collected at the checkstation included time in the field, hunting party size, age structure of harvest (tooth extraction), department-measured antler size, a more precise location of harvest (when needed), and caliber of firearm used. Moose ages were determined by counting cementum annuli of the lower incisors from hunter-harvested bull moose (Gasaway et al. 1978; Matson et al. 1993). Harvest data were summarized by regulatory year.

Unreported harvest was estimated from ADF&G-Subsistence Division reports (Andersen et al. 1998; Brown et al. 2004), historical information and public interviews (Table 13). The calculated proportional underreporting between subsistence harvest estimates (Andersen et al. 1998; Brown et al. 2004) and report card reporting from those years contributes the largest portion of the unreported estimate (RY96–RY99, RY01, RY02; Kaltag 4-yr $\bar{x}$ = 92% unreported, Nulato 4-yr $\bar{x}$ = 47% unreported, Galena 6-yr $\bar{x}$ = 42% unreported; Unit 21D combined weighted $\bar{x}$ = 56% unreported harvest for local residents). All other hunter unreported harvest was estimated at 17.7% (Gasaway et al. 1992). On an annual basis, additional unreported harvest was also obtained incidentally through hunter contacts, phone interviews, state trooper reporting, or reports. In RY08 the total estimated unreported harvest was approximated at 150 moose. However, because Unit 21D had become all drawing and registration permit hunts with more stringent reporting requirements since those Subsistence Division household surveys were last completed, I reduced the estimated unreported to 125 moose in RY10. Because that calculation included some level of ceremonial or potlatch harvest, known harvest for those uses was

subtracted from the 125 moose constant for the annual estimate (RY10–RY14). Potlatch, ceremonial, and cultural and education permit harvest data are recorded and stored in the office file cabinets of the Galena Area Biologist, and electronic copies of those memos are stored on the hard drive of the Galena Area Biologist in the moose harvest files.

We operated the Koyukuk River moose hunter checkstation annually during the reporting period. Moose teeth were collected at the checkstation for aging. Hunt information and hunter education opportunities were provided at the checkstation (e.g., meat care, landownership, moose biology, predator-prey interactions, reporting procedures). We evaluated meat salvage to measure success in meeting objectives under goals 3 and 4 (Stout 2012a). Each moose checked at the Koyukuk River checkstation was evaluated by ranking the level of dryness, cleanliness, smell, overall care, and days in the field. Rankings were subjectively scored on a scale of 1–5, with a score of 1 being low performance.

Results and Discussion

Harvest by Hunters

Harvest of moose in Unit 21D during RY10–RY14 was stable (Tables 13–15). Reduced harvest through restrictive hunting regulation during RY04–RY07 likely reversed the trend of declining bull:cow ratios in the Koyukuk CUA portion of Unit 21D, but hunting pressure relative to harvestable surplus in the Koyukuk River mouth and Pilot Mountain Slough areas was still high and likely suppressed bull:cow ratios in those areas. One cow was reported harvested during RY10–RY15, due to elimination of all antlerless moose seasons in the Unit 21D. However, illegal cow harvest continued to occur during winter. Potlatch, Stickdance, and ceremonial moose harvest also included cows.

During RY10–RY14 most harvest in Unit 21D was in the Koyukuk River drainage ($\bar{x}$ = 67%) of northern Unit 21D (Table 16).

Koyukuk River Checkstation Results

Three regulations monitored closely at the checkstation were antler width, salvage of meat, and destruction of trophy value of bulls harvested under subsistence registration permits. The regulation requiring meat to be left on the bone improved enforcement efforts to stop waste of moose meat. This regulation was adopted by the Board of Game in 1992 to address the increase of moose hunters and harvest in the Koyukuk CUA and to address the problem of some hunters removing only part of the meat from the carcass so they could carry lighter loads in their boats. At the checkstation, all hunters were notified of this regulation when we issued their permits and checked for compliance upon departure from the hunt area. Destruction of the trophy value of antlers at the checkstation was a controversial regulation when applied and seldom resulted in a positive public contact for the department when it was implemented. Beginning in RY00 hunters were required to cut the antlers at the kill site, which improved that aspect of hunter contact at the checkstation.

Table 13. Unit 21D moose harvest, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory	Harvest by hunters				Unreported	Potlatch/	
year	Bull	Cow	Unk	Total	harvest[b]	Stickdance[c]	Total
2010	286	0	0	286	113	12	411
2011	285	0	2	287	110	15	412
2012	267	0	0	267	111	14	392
2013	273	0	2	275	107	18	400
2014	258	0	0	258	112	13	383
2015[d]	311	1	1	313	115	10	438

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Unreported harvest based on ADF&G-Division of Subsistence door-to-door survey and other sources.
[c] Includes all potlatch, Stickdance, ceremonial, and cultural permit harvest.
[d] Preliminary data.

Table 14. Koyukuk River checkstation moose harvest, Interior Alaska, regulatory years[a] 2010–2015[b].

Regulatory			%	
year	Bull	Cow	Cow	Total
2010	237	0	0	238[c]
2011	242	0	0	242
2012	230	0	0	230
2013	261	0	0	261
2014	198	0	0	198
2015	236	1	0	237

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Moose harvested in Units 21D and 24.
[c] Includes moose of unknown sex.

Table 15. Koyukuk River checkstation[a,b] moose hunter residency and success, Interior Alaska, regulatory years[c] 2010–2015.

Regulatory	Local resident[d]		Nonlocal resident[e]		Nonresident		Total	
year	Hunter	Moose	Hunter	Moose	Hunter	Moose	Hunter	Moose
2010	255	100	203	120	26	13	484	233
2011	204	95	211	134	21	13	436	242
2012	249	110	199	104	22	16	470	230
2013	276	101	227	144	18	16	521	261
2014	214	83	210	104	7	6	431	193
2015	211	111	205	119	10	7	426	237

[a] Includes hunters reporting in both Units 21D and 24.
[b] Includes hunters reporting at Huslia.
[c] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[d] Local residents of Units 21B, 21D and 24.
[e] Other than local residents.

Table 16. Unit 21D distribution of reported moose harvest, north of the Yukon River and in the Koyukuk River drainage compared to remainder of southern Unit 21D, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory year	Percent harvest: Northern Unit 21D	Percent harvest: Southern Unit 21D	Total harvest
2010	69	31	283
2011	70	30	283
2012	68	32	260
2013	72	28	274
2014	56	44	257
2015[b]	60	40	311

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Preliminary data.

Total hunter success rates in the Koyukuk CUA were stable ($\bar{x}$ = 49.6%) during RY10–RY14. Harvest success in the fall hunt during RY10–RY14 was high for nonlocal residents ($\bar{x}$ = 57.6%) and nonresidents ($\bar{x}$ = 72.0%), but local resident success was lower ($\bar{x}$ = 41.2%). This was likely because many local hunting parties consisted of several family members who all obtained permits, but not all permit holders intended to harvest their own moose.

The Koyukuk CUA area is well known as an excellent area to hunt for large (≥50-inch antlers) moose. Of the bulls observed in the Koyukuk CUA TCAs surveyed during RY10–RY15, 39.8% had large antlers. During RY10–RY15, 52.2% of the harvested bulls measured in Koyukuk CUA permit hunts had large antlers (Table 17).

Meat evaluation surveys conducted at the checkstation indicated meat care was generally very good with an average overall score of 4.8 during RY10–RY15 (Table 18). Since RY10, no hunters were given average overall scores of less than 3. In general meat scores stabilized at a high level.

Permit Hunts

The subsistence registration permit that required antler destruction (RM832) was the permit used most by resident Alaskans to hunt within the Koyukuk CUA (Table 19). With implementation of drawing hunts in the remainder of Unit 21D (Tables 19 and 20), hunter numbers were better regulated and distribution of hunters improved. Resident hunters who did not want to destroy the trophy value of their bull moose and nonresidents could apply for a limited drawing permit.

Hunter Residency and Success

Hunter residency and success can be misleading because Unit 21D residents historically did not report unsuccessful hunt information reliably (Table 21; Stout 2012a). Harvest and hunter participation by Unit 21D residents during RY10–RY15 was relatively constant. Unit 21D local hunter success rates averaged 30% in RY10–RY14. Average success rate was 46% for nonlocal residents and $\bar{x}$ = 45% for nonresident hunters during RY10–RY14.

Table 17. Unit 21D large bull[a] moose percent harvested and number measured during the hunting season from the Koyukuk controlled use area hunts and percent counted during aerial surveys in the Koyukuk "Core-5" trend count areas, Interior Alaska, regulatory years[b] 2010–2015.

Regulatory year	% Harvested (Sep)	Number measured (Sep)	% Counted (Nov)[c]	Number counted (Nov)[c]
2010	50	205	36	657
2011	54	204	40	628
2012	52	190	–[d]	–[d]
2013	52	213	42	450
2014	54	153	41	440
2015	51	197	40	476

[a] Fifty-inch or greater antler spread.
[b] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[c] Data includes Huslia Flats and Treat Island trend count areas (Stout 2012b).
[d] No survey.

Table 18. Overall scores for meat evaluation at Koyukuk River checkstation, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory year	Avg no. days hanging	Avg clean score[b]	Avg dry score[b]	Avg smell score[b]	Avg overall score[b]	% Hunters scoring <3	Sample size (*n*)
2010	2.7	4.6	4.8	4.8	4.7	2.0	148
2011	2.6	4.4	4.8	4.9	4.7	0.0	158
2012	3.0	4.5	4.6	4.8	4.7	0.7	140
2013	2.9	4.6	4.8	4.9	4.9	0.0	164
2014	3.6	4.6	4.7	4.8	4.8	0.0	112
2015	3.0	4.7	4.8	4.9	4.9	0.0	146

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Subjective ranking scale of 1–5, with a score of 1 being lowest.

Table 19. Units 21D and 24 Koyukuk controlled use area moose harvest by permit hunt, Interior Alaska, regulatory years[a] 2010–2015.

Hunt	Regulatory year	Permits issued	Percent successful hunters[b]	Percent unsuccessful hunters[b]	Percent did not hunt	Bulls (%)	Cows (%)	Unk	Total harvest
RM832	2010	418	47	53	7	181 (100)	0 (0)	1	182
	2011	405	47	53	9	174 (100)	0 (0)	0	174
	2012	394	48	52	7	174 (100)	0 (0)	1	175
	2013	473	46	54	7	202 (100)	0 (0)	1	203
	2014	447	44	56	9	178 (100)	0 (0)	0	178
	2015[c]	425	55	45	8	214 (99)	1 (1)	0	215
DM823	2010	7	29	71	0	2 (100)	0 (0)	0	2
	2011	7	43	57	0	3 (100)	0 (0)	0	3
	2012	6	100	0	17	5 (100)	0 (0)	0	5
	2013	6	83	17	0	5 (100)	0 (0)	0	5
	2014	3[d]	100	0	0	3 (100)	0 (0)	0	3
	2015[c]	3[d]	67	33	0	2 (100)	0 (0)	0	2
DM825	2010	7	86	14	0	6 (100)	0 (0)	0	6
	2011	7	71	29	0	5 (100)	0 (0)	0	5
	2012	6	100	0	0	6 (100)	0 (0)	0	6
	2013	6	100	0	17	5 (100)	0 (0)	0	5
	2014	3	100	0	33	2 (100)	0 (0)	0	2
	2015[c]	3	100	0	33	2 (100)	0 (0)	0	2
DM827	2010	7	17	83	14	1 (100)	0 (0)	0	1
	2011	7	75	25	43	3 (100)	0 (0)	0	3
	2012	6	17	83	0	1 (100)	0 (0)	0	1
	2013	6	75	25	33	3 (100)	0 (0)	0	3
	2014	3	n/a	n/a	100	0 (0)	0 (0)	0	0
	2015[c]	3	33	67	0	1 (100)	0 (0)	0	1
DM828	2010	54	65	35	43	20 (100)	0 (0)	0	20
	2011	54	75	25	48	21 (100)	0 (0)	0	21

Hunt	Regulatory year	Permits issued	Percent successful hunters[b]	Percent unsuccessful hunters[b]	Percent did not hunt	Bulls (%)	Cows (%)	Unk	Total harvest
	2012	47	60	40	36	18 (100)	0 (0)	0	18
	2013	48	52	48	52	12 (100)	0 (0)	0	12
	2014	20	56	44	55	5 (100)	0 (0)	0	5
	2015[c]	20	63	37	60	5 (100)	0 (0)	0	5
DM829	2010	7	67	33	14	4 (100)	0 (0)	0	4
	2011	7	50	50	43	2 (100)	0 (0)	0	2
	2012	6	75	25	33	3 (100)	0 (0)	0	3
	2013	6	100	0	50	3 (100)	0 (0)	0	3
	2014	2	50	50	0	1 (100)	0 (0)	0	1
	2015[c]	2	100	0	0	2 (100)	0 (0)	0	2
DM830	2010	54	73	27	39	24 (100)	0 (0)	0	24
	2011	54	89	11	31	33 (100)	0 (0)	0	33
	2012	47	78	22	43	21 (100)	0 (0)	0	21
	2013	47	88	12	32	28 (100)	0 (0)	0	28
	2014	20	69	31	35	9 (100)	0 (0)	0	9
	2015[c]	19	64	36	26	9 (100)	0 (0)	0	9
Total	2010	554	50	50	14	238 (100)	0 (0)	1	239
	2011	541	53	47	16	241 (100)	0 (0)	0	241
	2012	512	51	49	13	228 (100)	0 (0)	1	229
	2013	592	50	50	13	258 (100)	0 (0)	1	259
	2014	498	45	55	12	198 (100)	0 (0)	0	198
	2015[c]	475	55	45	11	235 (100)	1 (0)	0	236

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Percent successful and percent unsuccessful were calculated using the total number of hunters who completed their report cards with enough information to determine whether they harvested a moose.
[c] Preliminary data.
[d] Includes (1) SM823 report.

Table 20. Unit 21D outside Koyukuk controlled use area moose harvest by permit hunt, Interior Alaska, regulatory years[a] 2010–2015.

Hunt	Regulatory year	Permits issued	Percent successful hunters	Percent unsuccessful hunters	Percent did not hunt	Bulls (%)	Cows (%)	Unk	Total harvest
DM814	2010	15	75	25	20	9 (100)	0 (0)	0	9
	2011	9	83	17	33	5 (100)	0 (0)	0	5
	2012	16	50	50	25	6 (100)	0 (0)	0	6
	2013	18	63	37	56	5 (100)	0 (0)	0	5
	2014	16	33	67	25	4 (100)	0 (0)	0	4
	2015[b]	16	46	54	23	6 (100)	0 (0)	0	6
DM815	2010	2	100	0	0	1 (100)	0 (0)	0	1
	2011	2	100	0	50	1 (100)	0 (0)	0	1
	2012	2	0	0	100	0 (100)	0 (0)	0	0
	2013	2	100	0	0	2 (100)	0 (0)	0	2
	2014	2	50	50	0	1 (100)	0 (0)	0	1
	2015[b]	2	100	0	50	1 (100)	0 (0)	0	1
DM816	2010	25	47	53	32	8 (100)	0 (0)	0	8
	2011	25	73	27	40	11 (100)	0 (0)	0	11
	2012	25	54	46	48	7 (100)	0 (0)	0	7
	2013	25	64	36	44	9 (100)	0 (0)	0	9
	2014	25	73	27	40	11 (100)	0 (0)	0	11
	2015[b]	25	71	29	32	12 (100)	0 (0)	0	12
DM817	2010	31	39	61	42	7 (100)	0 (0)	0	7
	2011	26	60	40	81	3 (100)	0 (0)	0	3
	2012	25	50	50	52	6 (100)	0 (0)	0	6
	2013	15	17	83	60	1 (100)	0 (0)	0	1
	2014	22	33	67	32	5 (100)	0 (0)	0	5
	2015[b]	24	42	58	50	5 (100)	0 (0)	0	5
DM818	2010	9	50	50	56	2 (100)	0 (0)	0	2
	2011	5	0	0	100	0 (0)	0 (0)	0	0
	2012	14	43	57	50	3 (100)	0 (0)	0	3
	2013	8	75	25	0	6 (100)	0 (0)	0	6
	2014	17	43	57	59	3 (100)	0 (0)	0	3
	2015[b]	20	60	40	50	6 (100)	0 (0)	0	6

Hunt	Regulatory year	Permits issued	Percent successful hunters	Percent unsuccessful hunters	Percent did not hunt	Bulls (%)	Cows (%)	Unk	Total harvest
DM819	2010	1	0	0	100	0 (0)	0 (0)	0	0
	2011	0	0	0	0	0 (0)	0 (0)	0	0
	2012	0	0	0	0	0 (0)	0 (0)	0	0
	2013	0	0	0	0	0 (0)	0 (0)	0	0
	2014	0	0	0	0	0 (0)	0 (0)	0	0
	2015[b]	0	0	0	0	0 (0)	0 (0)	0	0
DM820	2010	34	50	50	59	7 (100)	0 (0)	0	7
	2011	34	32	68	35	7 (100)	0 (0)	0	7
	2012	34	32	68	26	8 (100)	0 (0)	0	8
	2013	34	41	59	50	7 (100)	0 (0)	0	7
	2014	15	40	60	67	2 (100)	0 (0)	0	2
	2015[b]	15	43	57	53	3 (100)	0 (0)	0	3

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Preliminary data.

Table 21. Unit 21D moose hunter residency and success, Interior Alaska, regulatory years[a] 2010–2015.

	Successful					Unsuccessful					
Regulatory year	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	Total hunters
2010	126	143	17	0	286	297	146	24	0	467	754[c]
2011	117	155	16	0	288	256	180	14	1	451	740[c]
2012	116	137	20	0	273	239	181	28	0	448	721
2013	97	161	17	0	275	288	165	9	0	462	737
2014	107	144	7	0	258	249	190	20	0	459	717
2015[d]	139	160	13	1	313	179	154	6	0	339	652

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Unit 21D and Ruby residents only.
[c] Includes unknown success hunters.
[d] Preliminary data.

Harvest Chronology

There were no apparent changes in harvest chronology during RY10–RY14 (Table 22). However, about 20% of the estimated annual harvest probably occurred during winter as unreported harvest. Much of the unreported harvest was likely taken during October–March (Andersen et al. 1998; Brown et al. 2004).

Transport Methods

The presence of the Koyukuk CUA and the area's extensive river system made boats the primary transportation method during RY10–RY14 (Table 23). These patterns have changed little since 1980.

Other Mortality

Wolves and black bears (*Ursus americanus*) were common throughout Unit 21D. Grizzly bears (*U. arctos*) were common in the uplands of the Nulato Hills and Kaiyuh Mountains. Wolves and grizzly bears prey on both calf and adult moose. Hunters continued to report increased observations of grizzly bears during the fall moose season. Anecdotal reports by Unit 21D residents also suggested grizzly bears were increasing and becoming more common intruders at fish camps. Black bears were shown to kill more than 40% of moose calves (<5-months old) annually in Unit 21D (Osborne et al. 1991).

Alaska Board of Game Actions and Emergency Orders

No changes were adopted by the Alaska Board of Game (board) during RY10–RY14. In RY13 the September moose season in Unit 21D outside the Koyukuk CUA was reopened by emergency order during 27 September–3 October due to the unusual disruption caused by flooding on the Yukon River near Galena.

Recommendations for Activity 2.1.

Continue this activity but clarify the stated activity to include the Koyukuk CUA portion of Unit 24D.

ACTIVITY 2.2. Develop programs to improve moose harvest data and assessment for Unit 21D.

Data Needs

Like activity 2.1, harvest data from a moose database in WinfoNet are needed annually to assess trends in harvest. However, because reporting by hunters is lower among rural communities, additional effort is needed to collect those data.

Methods

We coordinated with Nulato, Kaltag, and Ruby community permit vendors to distribute and collect harvest report cards. We provided permits, assisted community hunting license vendors, and coordinated shipping of permit overlays and report cards. We attended public meetings and Fish and Game advisory committee meetings and provided information regarding the need for harvest data and moose population management.

Table 22. Unit 21D moose harvest chronology percent by month/day, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory year	Harvest chronology percent by month/day			
	8/22–8/31	9/1–9/14	9/15–9/25	*n*
2010	4	31	65	279
2011	3	35	62	285
2012	1	46	52	271
2013	1	32	67	264
2014	3	31	66	254
2015[b]	3	40	57	311

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Preliminary data.

Table 23. Unit 21D moose harvest percent by transport method, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory year	Harvest percent by transport method								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV[b]	Highway vehicle	Unknown	*n*
2010	4	0	90	3	0	0	2	0	284
2011	4	0	89	4	0	1	1	0	285
2012	3	0	91	3	0	0	2	1	266
2013	2	0	90	1	0	2	1	4	275
2014	4	0	90	2	0	1	1	2	257
2015[c]	2	0	92	4	0	0	0	2	313

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] ORV = off-road vehicle.
[c] Preliminary data.

Results and Discussion

Harvest data and checkstation results, including the meat evaluation survey and the hunter viewing survey, are found in Tables 13–23. Reporting by local residents continues to be an area for improvement. Permit vendors in the rural communities are an important resource for the department, and provide the clearest opportunity for improving local reporting. Updated Subsistence Division household surveys are needed to reassess the unreported harvest since drawing and registration permit hunts were implemented for all hunts in Unit 21D.

Recommendations for Activity 2.2.

Continue this activity but develop a decision framework that assesses harvest rates, harvestable surplus, and incorporates bull:100 cow ratios. The decision framework must prescribe a conservative strategy due to infrequent population estimates in Unit 21D and the generally poor harvest reporting rates. Clarify the activity to emphasize collection of harvest data and improve reporting from the communities of Kaltag, Nulato, and Ruby.

3. Habitat Assessment-Enhancement

ACTIVITY 3.1. Monitoring.

No monitoring activity occurred during RY10–RY14, and no changes are recommended.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Data Recording and Archiving

Moose survey records and memos are stored in the office file cabinets of the Galena Area Biologist, and electronic copies of those memos are stored on the hard drive of the Galena Area Biologist in the moose survey files.

Agreements

None.

Permitting

- ADF&G Collection Permit (Glenn Stout #99-014)
- ADF&G Collection Permit (Nathan Pamperin #09-042).

Conclusions and Management Recommendations

Moose were relatively numerous in the riparian lowlands of Unit 21D. The 2014 estimate was changed to 8,749 (with 15% presumed relative error of ±1,300 moose) observable moose in Unit 21D from the previous reporting period to correct calculation errors, but no population change was observed. During this reporting period the Unit 21D moose population may have increased slightly south of the Yukon River, but numbers were stable or declining in northern Unit 21D based on GSPE and TCA surveys. Cow numbers in TCAs throughout the unit continue

to be closely monitored. We recommend at least 1 high intensity GSPE survey and at least 2 low intensity GSPE surveys every planning period in the high density areas of the western Galena subarea portion of Unit 21D. Those surveys will be conducted in combination with the upper Koyukuk subarea portion of Unit 24D to assess the population management objective (Ver Hoef 2001, 2008; Kellie and DeLong 2006). Since RY10, high productivity as a result of increased twinning rates was likely an important factor in stabilizing the population in Unit 21D. Based on parturition rates of up to 80% (Boertje et al. 2007) with twinning rates averaging 34% in Unit 21D, an average of up to 107 calves:100 cows were produced annually during RY10–RY15. Because fall calf:cow ratios averaged 34 calves:100 cows, this suggests that 73 calves:100 cows died prior to the November fall surveys. Yearling bull:100 cow ratios averaged about 9 yearling bulls:100 cows. When multiplied by 2 to account for female yearlings, this suggests about 18 yearlings:100 cows survive to 17 months of age. Therefore, approximately 68% of the calves die in the first 5 months, and approximately 47% of the remaining cohort die in the next 12 months (total mortality to 17 months = 83%). This suggests average cohort recruitment is 17%. If adult mortality is 7.8% (Stout, *In prep*) and harvest is near 5%, then we are accounting for nearly 96% of the annual mortality. This appears to indicate there is little margin of error in our harvestable surplus calculations. Strength of individual cohorts may be more important to population trend than annual production and recruitment, therefore developing an age structure analysis from harvested moose teeth needs to be prioritized.

The key management issues facing Unit 21D during RY10–RY14 continued to be 1) cow harvest, 2) evaluation of harvest success rates, and 3) reallocation of harvest from state-qualified hunters to local federally-qualified subsistence hunters.

Cow harvest must decrease in northern Unit 21D if we are to achieve our population management objectives of 9,000–10,000 observable moose. The decline in bull:cow ratios within the Koyukuk CUA indicated harvest may have been too high during RY10–RY13, so drawing permits were reduced in RY14 and RY15. Bull:cow ratios appear to offer a more sensitive metric to assess harvestable surplus, where our knowledge of population and harvest rate calculations put us within 5% of the annual mortality estimates. Management efforts must continue to improve fall success rates by local hunters in order to reduce the winter harvest of cows.

The current population estimate of 8,749 observable moose (±1,300) in Unit 21D did not likely meet our management objective of 9,000–10,000 observable moose. A clear decision criterion for assessing this objective was not clearly stated in previous reports, therefore this assessment was subjective and continued to be problematic. I recommend an improvement in the wording of this objective and the area of comparison. The intensive management (IM) population objective of 7,000–10,000 moose was likely achieved, although for similar reasons, an assessment is challenging. Analysis of RY10–RY14 TCA data indicated poor recruitment in northern Unit 21D but good recruitment in southern Unit 21D. The objective to provide for a harvest of moose not to exceed 700 moose or 7% of the population was met. Estimated total harvest during RY10–RY14 averaged 400 moose including the estimate of unreported harvest (highest = 412 in RY11, lowest = 383 in RY14), which equaled a harvest rate of 4.4–4.7% of the estimated 8,749 observable moose. However, the IM annual harvest objective of 450–1,000 moose was likely not achieved during RY10–RY14. Although a harvest rate of 7% of the estimated population of 8,749 observable moose suggests a harvestable surplus of 612 moose was provided, stable or declining population trends probably indicated a 5% harvest rate (437 moose) was likely more

sustainable. The objective to provide for moose hunting opportunity, not to exceed 950 hunters per regulatory year, was achieved with a total of 754 hunters in RY10 being the highest number of hunters during the reporting period.

During RY10–RY15 we continued to monitor the objective to maintain an overall meat assessment score of less than "3" for ≤5% of the hunters each regulatory year at the Koyukuk River checkstation. Fewer than 5% of the hunters scored less than 3 on the overall meat care during RY10–RY15, and the average number of days hunters stayed in the field with their meat was less than 3.0 days. Therefore, the meat care objective was met. The number of days that meat remained in the field was an objective metric that was an improvement upon the standard harvest ticket data, and it was useful in showing that nonlocals tended to keep meat in the field longer ($\bar{x}$ = 3.5 days; n = 1,237 moose) than local hunters ($\bar{x}$ = 1.3 days; n = 537 moose). Although 3.5 days is a relatively short period, in warm years, the concern is that the upper end of that sample distribution of hunters may risk spoilage. That said, from RY02 through RY15, 96.1% (n = 1,856 moose) of harvested moose were checked out of the Koyukuk CUA within 7 days. This is the last report period for the meat evaluation assessment, and RY15 was the last year of data collection at the checkstation. In general, the meat evaluation at the checkstation was useful as an educational opportunity for meat care and for reassuring local residents that meat salvage was being enforced. However, before meat evaluation is attempted again, I recommend that a more objective methodology for determining quality of meat care is developed to measure moisture, contamination, and spoilage.

Because Unit 24D moose populations, harvest patterns, and management objectives are more consistent with Unit 21D, whereas Units 24A, 24B, and 24C are more consistent with one another, regrouping the game management unit reports accordingly is a possible future change I recommended in the Unit 24 report (Stout, *In prep*). I did not proceed with that change at this time, due to the complexity of changes that are already being addressed in this transitional report and the yet unforeseen changes resulting from the operational planning process. I also recommend an age structure analysis be conducted utilizing the extensive moose age database that has been collected from hunters passing through the Koyukuk checkstation. Additionally, I will also assess whether to propose a regulation change during the next reporting period to eliminate the positive finding for intensive management in Unit 21D. Because most Unit 21D moose occur and are harvested on federal lands within the unit, the management options available to ADF&G that would affect changes in habitat or predation are limited and not likely feasible.

Finally, because the Koyukuk River moose management plan is now more than 15 years old, I recommend that the goals and objective of the plan are discontinued, in favor of the goals and objectives in the Unit 21D and Unit 24 moose management reports and plans. However, some of these existing moose management report and plan goals and objectives retain important components of the Koyukuk River moose management plan. Over the course of 15 years since the plan was implemented, we accomplished many of the stated objectives and the Alaska Board of Game adopted many of the regulation changes which are still in place throughout much of the Koyukuk drainage and Unit 21D. The Koyukuk River moose management plan and working group proved to be a very effective process for incorporating and implementing public concerns into an effective moose management strategy.

II. Project Review and RY15–RY19 Plan

Review of Management Direction

MANAGEMENT DIRECTION

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

GOALS

Existing goals will be changed to the following single goal:

- Manage Koyukuk River drainage moose on a sustained yield basis to provide both hunting and other enjoyment of wildlife in a manner that complements the wild and remote character of the area and minimizes disruption of local residents' lifestyles.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

C1. Unit 21 has a positive finding for customary and traditional uses for moose and amounts reasonably necessary for subsistence uses of 600–800 moose from the unitwide population on an annual basis.

Intensive Management

C2. Population objective: 7,000–10,000 moose.

C3. Harvest objective: 450–1,000 moose.

MANAGEMENT OBJECTIVES

Existing management objectives will be changed to the following:

M1. Maintain a moose population of 5,200 observable moose in the Kaiyuh Flats and western Galena subareas.

M2. Maintain 30 bulls:100 cows in the Koyukuk CUA Core-5 TCAs.

M3. Provide for a harvest of moose not to exceed 700 moose or 7% of the annual moose population estimate each regulatory year.

M4. Provide for moose hunting opportunity not to exceed 950 hunters per regulatory year.

REVIEW OF MANAGEMENT ACTIVITIES

Recommended changes to management activities are noted below.

1. Population Status and Trend

ACTIVITY 1.1. Conduct geospatial population estimation (GSPE) surveys (objectives C1, C2, C3, M1).

Data Needs

A statistical estimate is needed to evaluate whether the objective to maintain a combined population of 5,200 observable moose in the western Galena and Kaiyuh Flats areas is achieved. An improved assessment of the harvestable surplus of moose in those high harvest portions of Unit 21D is needed.

In cooperation with the U.S. Fish and Wildlife Service (USFWS), we need to conduct high-intensity GSPE surveys once and low-intensity GSPE surveys twice during each 5-year reporting period, and we need to estimate abundance (90% CI <15%) to evaluate population status. We need calf:cow ratios (90% CI ± 10–20%) and yearling bull:cow ratios (90% CI ± 20–30%) to evaluate annual productivity and recruitment. We need total bull:cow ratios (90% CI ± 10–20%) to evaluate harvest sustainability.

Using the GSPE estimates, we need to estimate the total Unit 21D moose abundance to calculate harvest rate and harvestable surplus and assess objectives C1 and C2.

Methods

RY15–RY19

GSPE surveys are described in this document (see "I. RY10–RY14 Management Report | Management Activities | 1. Population Status and Trend | Methods"; Kellie and DeLong 2006). Input from biometric staff will be sought to verify and, if needed, refine the following methods prior to conducting the following portions of this activity to ensure that high scientific standards are retained in methods and interpretation of results.

- Maintain 70% high:30% low density sample unit (SU) ratio.
- In Unit 21D (in combination with Unit 24D) conduct a high intensity survey (<15% CI; 300–350 SUs) in the western Galena and Kaiyuh Flats subarea high density portions of Unit 21D, in combination with the upper Koyukuk subarea portion of Unit 24D, once every 5 years that includes an aerial stratification and at least 2 additional years of low intensity GSPE surveys (<20% CI; 275–300 SUs) for those areas during the 5-year period. The implementation of this will depend upon budget increments and will not likely occur until RY18, after the Unit 24B intensive management (Stout, *In prep*) program is concluded.

- Coordinate an assessment of the use of randomly-selected SUs and annually chosen TCA SUs to generate a statistically derived GSPE estimate for the low intensity surveys and the appropriate sample sizes.
- Complete sightability correction trials using radio collars if funding and other resources are available to deploy radio collars.
- Using GSPE estimates, TCA trend data, and extrapolated densities of moose in similar habitat for the unsurveyed portions of Unit 21D, calculate an extrapolated estimate of observable moose for the Unit 21D total area.
- Population estimate (upper range approximations; see activity 1.1, Methods) will be compared to the minimum level of the amounts reasonably necessary for subsistence, and the midpoint of the IM objectives. The upper 90% CI of the combined GSPE estimate for the western Galena and Kaiyuh Flats Slough subareas will be compared to the management objective of 5,200 observable moose.

ACTIVITY 1.2. Conduct trend count area (TCA) surveys (objectives C1, C2, M2).

Data Needs

We need to assess trend in ratio parameters and conduct a TCA survey annually in the Unit 21D Three Day Slough TCA. In cooperation with USFWS, we need to conduct TCA surveys in Dulbi River mouth, Koyukuk River mouth, Squirrel Creek, Kaiyuh Slough, and Pilot Mountain TCAs. We need calf:cow ratios and yearling bull:cow ratios to evaluate annual productivity and recruitment. We need total bull:cow ratios to evaluate harvest sustainability.

Methods

RY15–RY19

TCA survey methods are described in this document (see "I. RY10–RY14 Management Report | Management Activities | 1. Population Status and Trend | Methods"). Input from biometric staff will be sought to verify and, if needed, refine the following methods prior to conducting the following portions of this activity to ensure that high scientific standards are retained in methods and interpretation of results.

- In Unit 21D conduct an aerial survey of the Three Day Slough TCA (35 SUs; 193.6 mi^2).
- Every year in Unit 21D, in cooperation with USFWS, conduct an aerial survey of
    - the Dulbi River mouth TCA (20 SUs; 111.1 mi^2),
    - Koyukuk River mouth TCA (21 SUs; 118.8 mi^2),
    - Squirrel Creek TCA (16 SUs; 90.9 mi^2),
    - Kaiyuh Slough TCA (22 SUs; 126.3 mi^2),
    - Pilot Mountain Slough TCA (16 SUs; 91.0 mi^2)
- In Unit 21D, the midpoint estimate of the bull:cow ratio for the Koyukuk CUA will be compared to the management objective of 30 bulls:100 cows. The Huslia Flats and Treat Island TCAs in Unit 24D will be combined with the Koyukuk River mouth, Three Day Slough and Dulbi River mouth TCAs, and analyzed as the Koyukuk CUA Core-5 TCAs.

If USFWS is unable to continue cooperative survey efforts, we will reexamine the viability of this activity.

ACTIVITY 1.3. Conduct spring twinning surveys in Unit 21D (objectives C1, C2, M1).

Data Needs

Twinning surveys need to be conducted to collect twinning rate data which serve as indicators for body condition and productivity for cows. An assessment of body condition and productivity are integral to management on a long-term sustained yield basis and to protect moose habitat.

Methods

RY15–RY19

Twinning surveys are described in this document (see "I. RY10–RY14 Management Report | Management Activities | 1. Population Status and Trend | Methods | Spring Twinning Surveys" above. Input from biometric staff will be sought to verify and, if needed, refine the following methods prior to conducting the following portions of this activity to ensure that high scientific standards are retained in methods and interpretation of results.

- In Unit 21D observe a minimum of 50 cows with calves in the Three Day Slough/Dulbi River mouth areas (90% CI ± <40%).
- In Unit 21D, in cooperation with USFWS, observe a minimum of 50 cows with calves in the Natlaratlen River/Bear Creek and Pilot Mountain/Kaiyuh Slough areas (90% CI ± <40%).

ACTIVITY 1.4. Research age structure modeling techniques and determine whether harvested bull moose tooth-age data and aerial survey data from the Koyukuk CUA can be used to construct an age structure analysis in Unit 21D, in combination with the Unit 24D portion of the Koyukuk CUA (objectives C1, C2, C3, M1).

Data Needs

Using hunter-harvested moose teeth ages and survey data, we need to construct an age structure analysis of the moose population to evaluate annual contribution of individual cohorts to the harvestable surplus. An age structure analysis is needed to supplement a lack of aerial survey data in years of fiscal constraints or refine the assessment of aerial moose surveys that were conducted.

Methods

RY15–RY19

With biometric staff, research age structure modeling techniques and analyze moose age data from hunter-killed moose. Investigate funding options and contracting services to complete this analysis.

2. Mortality-Harvest Monitoring

ACTIVITY 2.1. In combination with the Koyukuk CUA portion of Unit 24D, monitor hunter use levels in the Koyukuk River drainage portion of Unit 21D (objectives C1, C3, M3, M4).

Data Needs

No change from the prior reporting period. Harvest estimates are needed to establish that the population is not being harvested in excess of sustained yield in the Koyukuk River drainage portion of Unit 21D, because nearly 70% of the annual harvest occurs in that portion of the unit. Harvest data from a moose database in WinfoNet is needed annually to assess trends in harvest. Moose harvested, harvest location, and hunter effort are critical elements needed to assess harvest trends and corroborate aerial survey observations.

Methods

RY15–RY19

Harvest data collection and data management are described in this document (see "I. RY10–RY14 Management Report | Management Activities | 2. Mortality-Harvest Monitoring and Regulations | Methods"). We will continue to operate the Koyukuk River checkstation. Input from biometric staff will be sought to verify and, if needed, refine our methods to ensure that high scientific standards are retained in our methods and interpretation of results.

ACTIVITY 2.2. Operate the Koyukuk River checkstation (objectives C1, C3, M3, M4).

Data Needs

Data collection is described in this report (see "I. RY10–RY14 Management Report | Management Activities | 2. Mortality-Harvest Monitoring and Regulations | Methods"). No change from the prior reporting period.

Methods

RY15–RY19

We will continue to operate the Koyukuk River checkstation. Input from biometric staff will be sought to verify and, if needed, refine our methods to ensure that high scientific standards are retained in our methods and interpretation of results.

- Hunters will be issued permits and provided with information on moose management, moose biology, and hunt regulations specific to the Koyukuk CUA.
- Measure antler morphology using the 7 standard measurements described by the Boone and Crocket Club for scoring moose antlers (https://www.boone-crockett.org/bgRecords/bc_scoring_moose.asp?area=bgRecords&type=Moose), as well as the count of left and right brow points. Record data on the data form in Appendix A. One of the 2 incisors (I_1 or I_2) will be extracted and attached by a wire to the antler measurement data form.
- Record hunter information on the data form in Appendix B.

- Record hunter check-in on the data form in Appendix C.
- Responses to hunter attempts to call-in moose will be recorded on the data form in Appendix D.

ACTIVITY 2.3. Develop programs to improve harvest data collection and assessment in Unit 21D (objectives C1, C3, M3, M4).

Data Needs

Like activity 2.1, harvest data in WinfoNet are needed annually to assess trends in harvest. However, because reporting by hunters among rural communities is lower than urban hunters, additional effort is needed to collect those data.

Methods

RY15–RY19

Harvest data collection and data management are described in this document (see "I. RY10–RY14 Management Report | Management Activities | 2. Mortality-Harvest Monitoring and Regulations | Methods"). Harvest objectives are an annual objective, therefore the estimated harvest will be compared on an annual basis. The estimated harvest will include the reported harvest plus an additional 125 moose (minus reported ceremonial, potlatch, or Stickdance harvest) to adjust for the unreported harvest. The estimated unreported harvest is based on Subsistence Division household surveys, historical management reports, and any other sources that may contribute to developing a minimum harvest estimate. The 125 moose adjustment is robust to ensure the population is managed conservatively. The annual estimated harvest will be compared to the lower range of the IM objectives and the point values of the management objectives. We will cooperate with Nulato, Kaltag, and Koyukuk community permit vendors to distribute and collect harvest report cards.

Using the Unit 21D moose population estimate and the estimated total harvest, we will assess harvest rate and harvestable surplus. Bull:100 cow ratios will complement the assessment and decision framework. Management decisions will be assessed conservatively due to the lack of broad population estimates and poor harvest reporting. In general, if harvestable surplus calculations suggest additional opportunity but the bull:100 cow ratio 5-year trend is simultaneously declining, conservative harvest will be adopted and deference will be given to the bull:100 cow ratios. Furthermore, if harvestable surplus calculations suggest decreasing opportunity but the bull:100 cow ratio 5-year trend is increasing, deference will be given to the harvestable surplus calculation.

Input from biometric staff may be sought to verify and, if needed, refine our methods to ensure that high scientific standards are retained in our methods and interpretation of results.

3. Habitat Assessment-Enhancement

No habitat assessment will be conducted.

ACTIVITY 3.1. Monitoring.

Data Needs

No change from prior reporting period. Monitoring activity is not recommended at this time.

Methods

No change from prior reporting period.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Data Recording and Archiving

- GSPE/TCA Moose Survey Form (Stout, *In prep*; Appendix A).
- Stratification Flight Survey Form (Stout, *In prep*; Appendix B).
- Moose Twinning Survey Form (Stout, *In prep*; Appendix C).

Global Position System (GPS) location data will be logged using WGS 84 datum. GPS files will be stored on the Galena Area Biologist hard drive D:/Moose/Surveys/[year]. Files will be saved using MapSource (Garmin Ltd., 2008, Ver. 6.13.7) as *.gpx files. Alternatively, location data for analysis and mapping will use ArcGIS (esri 2013. ArcGIS Desktop: Release 10.2.2. Redlands, California: Environmental Systems Research Institute and will be stored on the Fairbanks Regional DWC hard drive, S:/Stout/Moose/[year]. Memos and data files will be archived in the Data Archive tool in WinfoNet. The D drive of the Galena Area Biologist's hard drive will be backed up weekly onto the Area Biologist's "H" network drive.

Hard copies of species wildlife management reports and plans and the intensive management operational plan for Moose – Unit 21D will be stored in the Fairbanks Regional Office Library and online at http://www.adfg.alaska.gov/index.cfm?adfg=librarypublications.wildlifemanagement. Memos, data forms, and additional hard copies will be stored in the Galena Area Biologist files in Fairbanks and Galena offices.

Electronic copies of data, GPS location data, memos, and reports will be stored in the WinfoNet – Data Archive. Project Title: Moose Management Program. Project ID: GMU 21D. Primary Region: Region III.

Agreements

None.

Permitting

- ADF&G Collection Permit (Glenn Stout #99-014)
- ADF&G Collection Permit (Nathan Pamperin #09-042).

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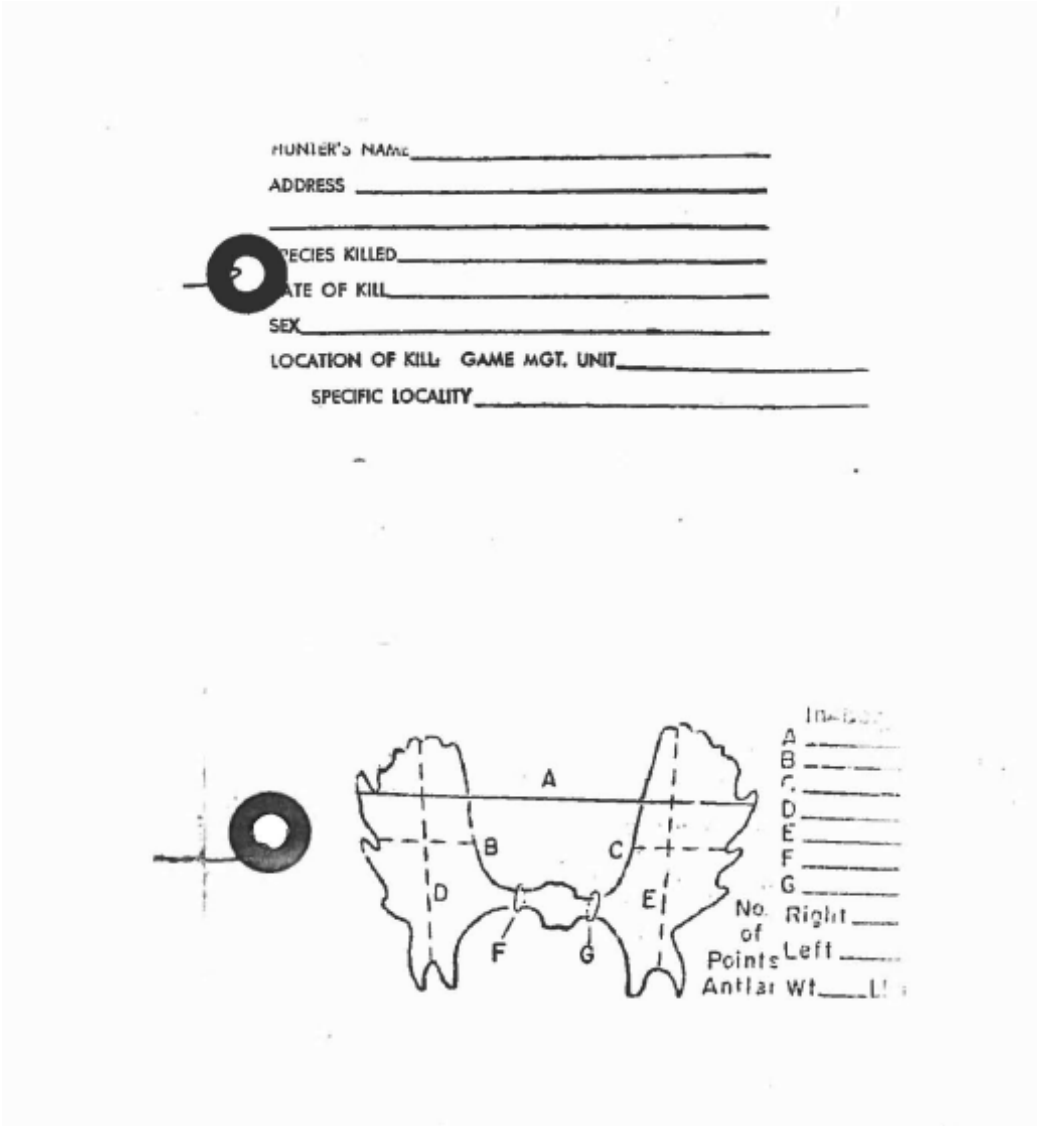
Appendix A. Koyukuk moose tooth and antler measurement data form, Interior Alaska, 2016.



Appendix B. Lower Koyukuk River moose hunter checkstation form, Interior Alaska, 2016.

Roll sheet - Hunter #_____

2016 - MOOSE HUNTER CHECK STATION FORM – Lower Koyukuk River

Hunter Permit #_____

Date Registered:_____, 2016 Time:_____

Hunter Name:_____

Mailing Address:_____

City:_____ State:_____ Zip:_____

Number of hunters in boat:_____ In Party:_____

Hunting License #_____ Boat ID #'s:_____

Kind of boat used: Jetboat Outboard Rubber Raft Other:_____

Boat Registration #_____

Boat Access: _____ Rifle Caliber:_____

Date out:_____, 2016

Other Hunters in Party:_____

Additional trip dates:_____

Name of Guide or Transporter:_____

Moose taken: Yes No Date of Kill:_____, 2016

Sex: Bull Cow Antler measured: Yes No

Kill location:_____

GMU/UCU:_____ Tooth taken: Yes No Age:_____

Comments:_____

_____

Appendix C. Lower Koyukuk moose hunter checkstation roll sheet, Interior Alaska, 2016.

2016 – Moose Hunter Check Station Roll Sheet – Lower Koyukuk

Hunter #	Date in	Name	Home town	Date out	Sex of moose
1					
2					
3					
4					
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40					

Hunter #	Date in	Name	Home town	Date out	Sex of moose
41					
42					
43					
44					
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Appendix D. Koyukuk checkstation moose calling form, Interior Alaska, 2016.

2016 KOYUKUK CHECKSTATION MOOSE CALLING FORM

Instructions: Begin with number 1 in "hunter" column and number sequentially; SKIP a line when going to the next boat
Residency is L for local; N for Nonlocal; NR for Nonresid; DOK is Date of Kill; Date Out is Date through Check Station

Hunter	Residency	DOK	Date Out	# Spike/Fork bulls observed	Spike/Fork bulls passed (Y/N)	Comments (why passed?)	Called in?


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