Moose Management Report and Plan, Game Management Unit 24:

Report Period 1 July 2010–30 June 2015, and

Plan Period 1 July 2015–30 June 2020

Glenn W. Stout

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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 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, Management Coordinator for Region III 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 24 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 24.

I. RY10–RY14 Management Report

Management Area

Unit 24 (26,068 mi^2; Subunits 24A = 4,146 mi^2, 24B = 13,523 mi^2, 24C = 3,049 mi^2, 24D = 5,350 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 24 include the Brooks Range, Ray Mountains, Kobuk Ridges, and Yukon River lowlands (Nowacki et al. 2001). Maps for Unit 24 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 24

Moose are broadly distributed throughout much of Unit 24 with local densities (0.25–2.0 observable moose/mi^2) typical of Interior Alaska. Anecdotal evidence indicates the population was low prior to the 1930s but increased during the 1930s–1950s (Huntington 1993). The rate of increase was probably slow until predator control efforts in the 1950s allowed rapid expansion of local populations, especially in the southern third of the unit. During the early 1970s the population leveled off in some areas. Populations apparently climbed again in the late 1980s, peaked around 1992, then fell gradually through the remainder of the 1990s.

Naturally occurring wildfires and floods are major forces affecting the productivity and diversity of moose habitat in this area. Habitat is excellent along most of the Koyukuk River lowlands, providing extensive areas of winter browse and aquatic vegetation in summer and fall. Lightning-caused fire is a frequent event, and large areas of the burned uplands are productive browse communities. Based on habitat surveys in spring 2007, browse production is not limiting the size of the moose population in most of Unit 24 (Paragi et al. 2008).

The Koyukuk River and major tributaries are popular moose hunting areas for Unit 24 residents, other Alaska residents, and nonresidents. The lower portion of the Koyukuk River within Unit 24 has been the focus of most of our management effort because of the long history of use, higher moose densities, and increasing hunting activity. Hunting activity was also increasing in other areas of the unit, including rivers accessible from the Dalton Highway. Two controlled use areas (CUA), the Koyukuk CUA and the Kanuti CUA, restrict use of aircraft for moose hunting activities. The Dalton Highway corridor management area prohibits use of off-road vehicles and firearms for hunting within 5 miles on either side of the Dalton Highway, except for federally qualified rural residents. Access to portions of Unit 24 increased with the opening of the highway to the public in 1981.

There are several moose hunting seasons in Unit 24 that reflect the variety of moose densities and human-use patterns. In addition to the usual September hunting season, open seasons in state and federal regulations from December through April also provide hunting opportunity for residents of Alaska. A registration permit moose hunt was established in 1996 in the Koyukuk CUA downstream from Huslia. Drawing hunts were established in the Koyukuk CUA in 2000, the Dalton Highway corridor management area in 2002, and drainages around the Koyukuk CUA in 2004.

Annual reported harvest did not exceed 100 moose until 1980 and was highest in 1999 at 240 moose (Stout 2014a). Unreported harvests during this period probably were 160–300 moose per year (Woolington 1998). Local residents have become more aware of the importance of harvest reporting, resulting in increased compliance with reporting requirements.

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 [*Canis lupus*]) and a recommendation to implement aerial wolf control to make progress toward intensive management objectives for moose abundance and harvest.

- The *Operational Plan for Intensive Management of Moose in Game Management Unit 24(B) during Regulatory Years 2012–2017* was published in 2012 (ADF&G 2012). This operational plan defined an experimental program for wolf control in an area including the villages of Allakaket and Alatna to benefit moose survival for increasing sustainable harvest of moose. The operational plan complements the intensive management plan in regulation (5 AAC 92.124).

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.

- Reduce meat spoilage by hunters.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

Unit 24 has a positive finding for customary and traditional uses for moose and amounts reasonably necessary for subsistence uses of 170–270 available moose.

Intensive Management

	Moose	
Unit	Population objective	Harvest objective
24A	1,200–1,500	75–125
24B	4,000–4,500	150–250
24C	1,000–1,500	50–125
24D	5,000–6,000	225–425

MANAGEMENT OBJECTIVES

1. Maintain a moose population of 10,000–12,000.
2. Provide for a harvest of moose not to exceed 360 moose or 5% of the annual moose population estimate each regulatory year.
3. Provide for moose hunting opportunity not to exceed 500 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 moose population of 10,000–12,000 moose was achieved. A statistical estimate of the moose population derived from geospatial population estimator (GSPE) surveys 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 are 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 fall population estimation surveys and analyzed data from all population estimation surveys using the GSPE method (Ver Hoef 2001, 2008; Kellie and DeLong 2006). GSPE surveys since 1999 were conducted in the fall according to methods and in areas described in Stout (2010).

In 2010 Koyukuk National Wildlife Refuge (NWR) staff conducted a survey of a 1,361 mi^2 area on the western portion of the refuge in Unit 24D using GSPE methods described by Stout (2010). In 2011 we completed a GSPE survey in a portion of Unit 24D that overlapped the area conducted in 2004 described by Stout (2010). Methods and results of the 2011 survey are described in the Unit 21D report (Stout 2012a).

In 2010, 2011, 2013, and 2015 we completed GSPE surveys on the Kanuti NWR in Unit 24B covering 2,715 mi^2 and a 1,021 mi^2 area west of the Kanuti NWR referred to as the upper Koyukuk management area. The Kanuti NWR portion of the survey area overlapped with surveys conducted during 1999–2008. Stratification of sample units (SU) for the 2010 and 2015 survey were conducted using a Cessna 207 or similar aircraft. Intensively surveyed SUs were flown from small fixed-wing aircraft (PA-18 or similar aircraft) described by Stout (2010). In 2010 we intensively surveyed 205 SUs (69 high density, 136 low density; 1,092 mi^2) of 701 SUs (3,736 mi^2; Stout 2010; T. Craig, U.S. Fish and Wildlife Service [USFWS], and G. Stout, ADF&G, unpublished survey report, February 2011, Fairbanks). In 2011 we intensively surveyed 151 SUs (75 high density, 76 low density; 805 mi^2) of 701 SUs (3,736 mi^2; T. Craig and G. Stout, unpublished survey report, February 2012). In 2013 we intensively surveyed 129 SUs (74 high density, 55 low density; 687 mi^2) of 701 SUs (3,736 mi^2; T. Craig and G. Stout, unpublished survey report, February 2014). Due to limited funding, the 2011 and 2013 surveys used stratification data from the RY08 and RY10 surveys (75 high density SUs, 627 low density SUs). In 2015 following the aerial stratification survey (138 high density SUs, 563 low density SUs), we intensively surveyed 171 SUs (102 high density, 69 low density; 911 mi^2) of 701 SUs (3,736 mi^2; R. Churchwell [USFWS] and G. Stout, unpublished survey report, May 2016). Using radiocollared moose present in the survey area, we estimated a sightability correction factor (SCF; Boertje et al. 2009) for the 2008 and 2010 surveys. We used the Bayesian method for trend analysis described by Ver Hoef (2001) and applied a multiplicative mixed-effects model for the 1999–2015 Kanuti surveys. For that trend analysis, we applied SCFs of 1.27 and 1.05 to the 2008 and 2010 results, respectively. The average of those 2 years (SCF = 1.16) was applied to the remaining Kanuti NWR GSPE estimates during 1999–2015.

Unit 24 moose population estimates for RY14 were obtained using methods described in Stout (2010). 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 were derived from results of GSPE surveys or counts from fall trend count area (TCA) surveys. Moose in 4 TCAs (Dulbi Slough, Huslia River flats, Treat Island, and Middle Fork) 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). These surveys were conducted in cooperation with staff from the Koyukuk NWR, Kanuti NWR, and the Bureau of Land Management (BLM) in RY10–RY15. Due to low snow and poor survey conditions, no TCA or GSPE surveys were conducted by ADF&G in RY12.

Spring Twinning Surveys. Twinning surveys were flown in late May and early June in RY10, RY11, RY13, and RY14 to determine the proportion of moose cows with twin calves among all cows with calves in the Huslia Flats and Kanuti Flats areas. Twinning surveys were flown during RY10–RY13 in Units 24A and 24B. Observation of 50 cows with calves was the desired minimum to increase the power of statistical comparisons between survey areas and across years, but funding and weather sometimes prevented us from achieving that goal. Surveys consisted of non-overlapping transects at <500 feet above ground level in PA-18 or similar aircraft with experienced pilots and observers. Moose were classified as bull, yearling, calf, cow, cow with 1 calf, or cow with 2 calves. Timing was critical, so surveys were flown in late May and early June during or 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 Units 24A and 24B 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.

Results and Discussion

Population Size

Units 24A and 24B. GSPE surveys were completed in RY10, RY11, RY13, and RY15, and estimates are reported (Tables 1–5). In the RY10 Kanuti GSPE survey, we classified 409 moose and estimated a total of 1,068 moose (±11.5%; 90% CI; 0.39 moose/mi^2) on the Kanuti NWR in Unit 24B, not including an SCF. In the 2011 GSPE survey, we classified 316 moose, and estimated 797 moose (±19.3%; 90% CI; 0.29 moose/mi^2) in the same area, not including an SCF. In the 2013 GSPE survey, we classified 259 moose, and estimated 551 moose (±25.7%; 90% CI; 0.20 moose/mi^2) in the same area, not including an SCF. The RY13 survey had lower precision due to low sample size, and survey conditions were subjectively rated low by observers.

Table 1. Unit 24B Kanuti National Wildlife Refuge population estimation surveys, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Calves:100 cows	Yearling bulls:100 cows	Percent calves	Adults	Population estimate (90% CI[b])	Moose/mi^2
2010	2,715	51	33	8	17.5	861	1,068 (±11.5%)	0.39
2011[c]	2,715	69	41	10	19.9	656	797 (±19.3%)	0.29
2013[c]	2,715	65	36	11	19.6	466	551 (±25.7%)	0.20
2015[c]	2,715	62	52	10	24.7	878	1,158 (±18.3%)	0.43

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Confidence interval (% ±).
[c] GSPE survey estimate, without sightability correction factor.

Table 2. Unit 24B upper Koyukuk management area[a] geospatial population estimation surveys, Interior Alaska, regulatory years[b] 2010–2015.

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Calves:100 cows	Yearling bulls:100 cows	Percent calves	Adults	Population estimate (90% CI[c])	Moose/mi^2
2010	1,340	52	34	8	18.3	328	405 (±23.9%)	0.30
2011[d]	1,340	103	49	8	18.8	250	324 (±29.0%)	0.24
2013[d]	1,340	67	37	11	17.4	243	300 (±31.4%)	0.22
2015[d]	1,340	78	54	13	23.1	396	509 (±26.9%)	0.38

[a] Area partially overlaps Kanuti National Wildlife Refuge survey area.
[b] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[c] Confidence interval (% ±).
[d] Without sightability correction factor.

Table 3. Units 24C and 24D geospatial population estimation (GSPE) survey, Interior Alaska, regulatory year 2007[a].

Area	Survey area (mi^2)	Bulls:100 cows	Calves:100 cows	Yearling bulls:100 cows	Percent calves	Adults	Population estimate (90% CI[b])	Moose/mi^2
Eastern Koyukuk NWR	1,623	78	42	14	18.7	796	983 (±9.5%)	0.61
Hogatza River	2,672	70	45	16	20.7	442	562 (±23.0%)	0.21
GSPE calculated total	4,295	75	43	14	19.4	1,239	1,545 (±10.6%)	0.36

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2007 = 1 July 2007–30 June 2008).
[b] Confidence interval (% ±).

Table 4. Unit 24 total population estimation summary, Interior Alaska, regulatory years[a] 2004–2015.

Survey area	Area mi^2	Total sample units	Bulls:100 Cows	Calves:100 Cows	Population estimate without sightability correction factor[b]
Units 24A and 24B[c]					
2008 Estimated	8,779				1,929±550
2004–2015 Survey block avg., (Kanuti NWR)[d]	2,715	508	61:100	40:100	977±219
Moose habitat Unit 24, North[e]	3,402				595±200
Remainder Unit 24, North[f]	3,150				158±100
Subtotal (2004–2011)	18,046				3,659±1069
Unit 24C[c]					
2007 Survey block (Hogatza River)	2,672	498	70:100	45:100	562±129 (90% CI)
Subtotal (2007)[d]	2,672				562±130
Unit 24D[g]					
2011 Survey block (lower Koyukuk)[d]	1,843	336	38:100	23:100	2,627±210 (90% CI)
2007 Survey block (eastern Koyukuk refuge)[d]	1,623	296	78:100	42:100	983±93 (90% CI)
2010 Survey block (western Koyukuk refuge)[d,h]	1,361	249	79:100	28:100	640±139 (90% CI)
Remainder Unit 24D	523				130±35
Subtotal (2007–2011)	5,350				4,380±477
Unit 24 – Total	26,068				8,601±1,676

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2004 = 1 July 2004–30 June 2005).
[b] Values following (±) symbol without a 90% CI designation are range approximations and are not statistically derived confidence intervals.
[c] Cumulatively, Units 24A (4,146 mi^2), 24B (13,523 mi^2), and 24C (3,049 mi^2) were formerly defined as Management Zone 2 (Stout 2006).
[d] Geospatial population estimation survey.
[e] The estimated area of Units 24A and 24B that could potentially support moose year-round, based primarily on occurrence of rocky slopes, altitude, and deciduous canopy.
[f] The area remaining in Units 24A and 24B with very little year-round moose habitat, primarily the high altitude mountainous portion within Gates of the Arctic National Park.
[g] Unit 24D (5,350 mi^2) was formerly defined as Management Zone 1 (Stout 2006).
[h] Survey results provided by Koyukuk National Wildlife Refuge.

Table 5. Unit 24A Middle Fork trend count area aerial moose composition counts, Interior Alaska, regulatory years[a,b] 2011–2015.

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
2011	113.6	21	5	30	6	20	92	0.81
2015	113.6	58	4	18	2	10	88	0.77

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2011 = 1 July 2011–30 June 2012).
[b] Bureau of Land Management data.

In the 2015 GSPE survey, we classified 483 moose, and estimated 1,158 moose (±18.3%; 90% CI; 0.43 moose/mi^2) in the same area, not including an SCF. The unbiased estimate of 1,158 moose (±18.3%; 90% CI) in RY15 was significantly different from the RY13 estimate. However, the multiplicative mixed-effects model for 1999–2015 indicated the population trend was stable ($\lambda = 0.9942$ (±0.9585–1.034); Figure 1; J. Merickel, ADF&G Biometrician, memorandum, 7 March 2016, Fairbanks) for the Kanuti survey area.

I estimated the RY14 moose population in Units 24A and 24B to be 3,659 observable moose (±1,069) based on the RY10, RY11, RY13, and RY15 GSPE surveys in Unit 24B and data reported in Stout (2010). In the Middle Fork TCA, moose density without an SCF was relatively unchanged at 0.81 moose/mi^2 in RY11, and 0.77 moose/mi^2 in RY15 (Table 5).

The upper Koyukuk management area estimates in Unit 24B did not change significantly during RY10–RY15 (Table 4).

Unit 24C. I estimated the RY14 moose population to be 562 observable moose (±130) based on the 2007 GSPE data (Tables 3 and 4; Stout 2012a).

Unit 24D. During RY10–RY14, moose were numerous based on previous surveys and inference from TCAs in the Koyukuk River lowlands in Unit 24D (1.5–4.3 moose/mi^2, Stout 2014a). Based on recruitment parameters, the population probably began to stabilize beginning around 2003–2004 (Stout 2010). I estimated the RY14 moose population to be 4,380 moose (±477; Table 4) based on the 2010 and 2011 GSPE surveys and estimates reported in Stout (2012a). However, density in TCAs declined every year during RY10–RY14, suggesting this estimate based on the 2010 and 2011 GSPE surveys may be outdated. The RY15 TCA surveys indicated calf production was exceptional, which, if good survival occurs in that cohort, could offset the previous 4 years of declines.

All of Unit 24. Surveys through RY15 helped refine the overall estimate within Unit 24. I estimated the total Unit 24 population to be 8,509 observable moose ±1,587 (6,922–10,096) at the end of RY10, based on the addition of extrapolated population estimates previously reported (Stout 2010) and estimates reported for each subunit (Table 4). Although the RY15 GSPE survey indicated no change in trend for the Kanuti moose population estimate, I used the average of the multiplicative mixed-effects model estimates for 1999–2015 of 977 (±219) moose to generate the Unit 24B estimate. Including the adjustment to the Unit 24B portion but no changes in the remainder of Unit 24, I estimated the Unit 24 population at 8,601 observable moose ±1,676 (6,925–10,277) at the end of RY14.

Population Composition

Population composition from TCA and GSPE surveys conducted during RY11–RY13 throughout Unit 24 were highly variable (Tables 1–8). Generally, moose density trends in TCAs corroborated GSPE composition data and indicated the population declined through RY03 in most of Unit 24 but began to stabilize from RY04–RY06 to RY14.

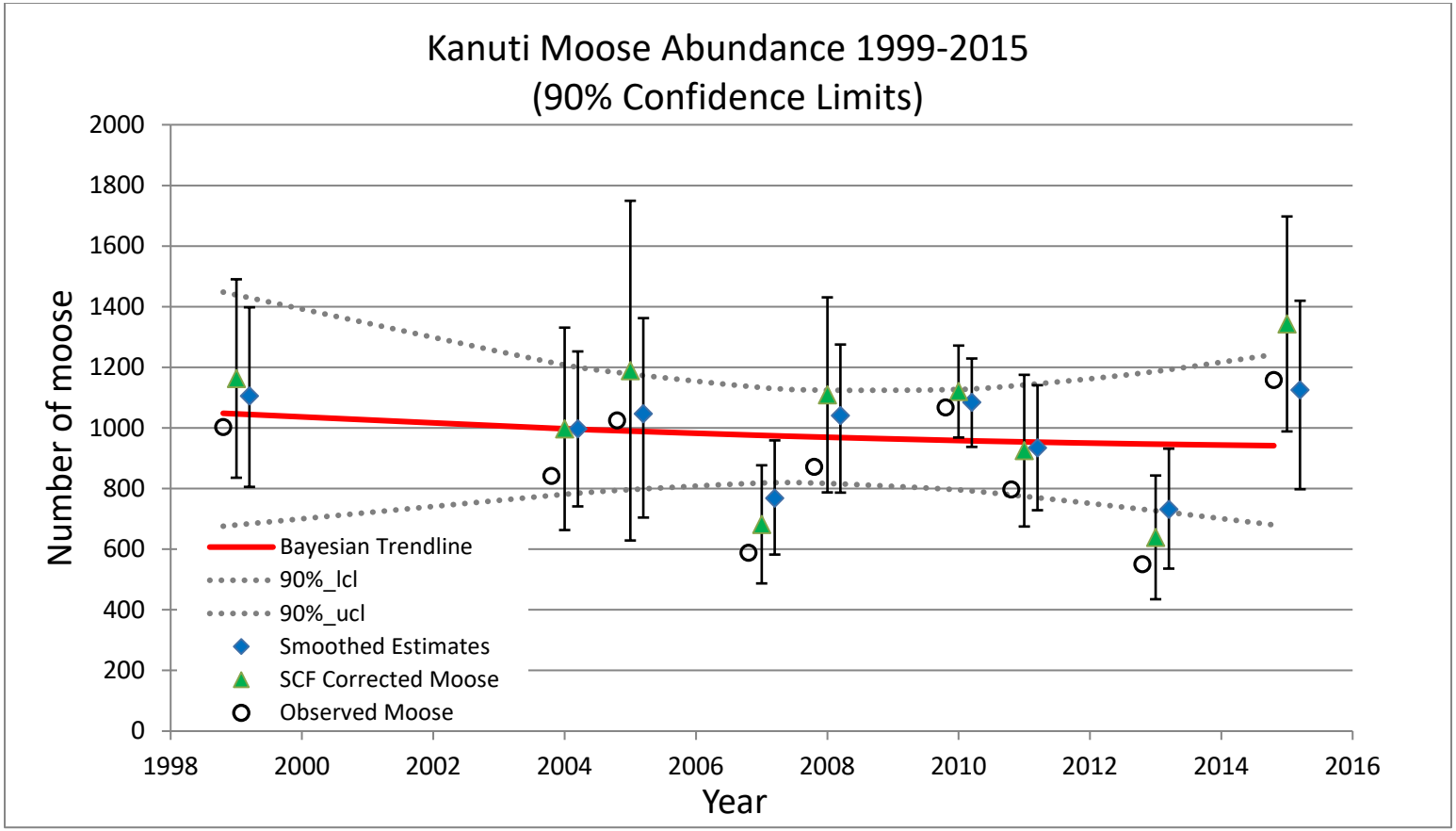

Figure 1. Trend since 1999 was estimated with a multiplicative mixed-effects model using Bayesian methods and the software WinBUGS (Lunn et al. 2000). A multiplicative model assesses a proportional change in slope as opposed to a linear model, which evaluates an additive change in slope. Lambda (λ) is estimated directly by the multiplicative model. The posterior mean of λ = 0.9942 (SE = 0.024). A 90% Bayesian credible interval for λ is (0.9585, 1.034). Because 1 is contained in the 90% credible interval we can conclude that with 90% probability the true value of λ is not different from 1.

Table 6. Unit 24D Dulbi Slough trend count area aerial moose composition counts, Interior Alaska, regulatory years[a,b] 2011–2015[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
2011	132.8	47	10	32	9	17.6	204	1.5
2014	138.3	30	3	18	0	12.4	177	1.3
2015	132.8	32	4	18	5	12.0	167	1.3

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2011 = 1 July 2011–30 June 2012).
[b] U.S. Fish and Wildlife Service data.
[c] Beginning in 2001, surveys used geospatial population estimator sample units (Kellie and DeLong 2006).

Table 7. Unit 24D Huslia River flats trend count area aerial moose composition counts, Interior Alaska, regulatory years[a,b] 2010–2015[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	142.3	33	8	30	4	18.2	632	4.4
2011	125.9	42	15	24	3	14.6	541	4.3
2013	125.9	31	6	21	2	13.6	433	3.4
2014	142.3	39	9	17	6	10.7	466	3.3
2015	142.3	29	8	38	11	22.7	555	3.9

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] U.S. Fish and Wildlife Service data.
[c] Beginning in 2001, surveys used geospatial population estimator sample units (Kellie and DeLong 2006).

Table 8. Unit 24D Treat Island trend count area aerial moose composition counts, Interior Alaska, regulatory years[a,b] 2010–2015[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	163.3	39	7	21	5	12.7	688	4.2
2011	163.3	36	7	18	3	11.8	601	3.7
2013	163.3	29	5	20	3	13.5	496	3.0
2014	163.3	40	8	18	2	11.5	391	2.4
2015	163.3	37	10	34	14	19.8	626	3.8

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] U.S. Fish and Wildlife Service data.
[c] Data reported prior to 2001 used Gasaway et al. (1986) sample units. Beginning in 2001, surveys used geospatial population estimator sample units (Kellie and DeLong 2006).

Bull:Cow Ratios. Bull:cow ratios >30 bulls:100 cows observed in TCA and GSPE surveys (Tables 1–8) indicate the bull component of the population was not overharvested in Unit 24 during RY10–RY14, and breeding activity was unaffected, even in Unit 24D. Schwartz (1998) suggested a ratio of 20–30 bulls:100 cows is needed to ensure breeding of all available cows. GSPE surveys indicated ratios of 38 bulls:100 cows in Unit 24D but ranged as high as 65–70 bulls:100 cows in Units 24B and 24C. Bull:cow ratios during RY11 (21 bulls:100 cows) and RY15 (58 bulls:100 cows) in the Middle Fork TCA (in Unit 24A) were questionable due to small sample size (Table 5). In general, most ratios in TCAs with counts of less than 100 moose tended to have larger annual variation that made interpretation difficult.

Unit 24D bull:cow ratios during RY10–RY14 were generally stable in the Huslia River flats (29–42 bulls:100cows), Treat Island (29–40 bulls:100 cows), and Dulbi Slough (32–47 bulls:100 cows) TCAs (Tables 6, 7, and 8) and were typically lower than the GSPE composition data (Tables 1–4). This can likely be explained by higher hunting pressure in higher density moose areas near river riparian areas. The higher density moose areas typically attracted higher levels of hunting pressure because they were more accessible by boat.

Calf and Yearling Ratios. Ratios of calves and yearlings to 100 cows in Unit 24D were variable. Combined averages for Huslia Flats and Treat Island TCAs in Unit 24D indicated calf recruitment to 5 months of age was low in the 4 surveys conducted during RY10–RY14 $\bar{x}$ = 21.1 calves:100 cows. Yearling recruitment during RY10–RY14 ($\bar{x}$ = 8.1 yearling bulls:100 cows) appeared only slightly below normal. Results from the GSPE survey on the Kanuti NWR in Unit 24B in RY10, RY11, RY13, and RY15 indicated that recruitment to 5 months of age averaged 40.5 calves:100 cows, and recruitment to 17 months of age averaged 9.8 yearling bulls:100 cows.

Spring Twinning Surveys. Radio collars deployed in March 2008 in the upper Koyukuk River drainage in Units 24A and 24B combined, allowed us to obtain adequate sample sizes during RY10–RY13. Results indicated high twinning rates (4-yr $\bar{x}$ = 43.5; Table 9). Based on these twinning rates and an estimated parturition rate of up to 80% (Boertje et al. 2007), an average of 115 calves:100 cows were likely produced annually during RY10–RY13. Using calf and yearling ratios along with these twinning survey results indicates that approximately 62% of a calf cohort was lost in the first 5 months, and approximately 18% of that cohort was lost in the next 12 months (total mortality to 17 months = 80%). During RY10–RY14, twinning rates in the lower Koyukuk drainage in Unit 24D were relatively lower (4-yr $\bar{x}$ = 28.5%; Table 10), likely due to higher densities. However, 28.5% is still fairly high and does not suggest density dependent nutritional limitations are occurring that would negatively impact habitat (Boertje et al. 2007).

Recommendations for Activity 1.1.

- Continue GSPE and TCA surveys annually and evaluate abundance, productivity, survival, recruitment, and sex ratios. Utilize memos to archive details of surveys and keep management reports concise.

- Continue twinning surveys in Unit 24D annually and evaluate abundance, body condition, and productivity. Discontinue twinning surveys in Units 24A and 24B because densities are lower in the upper Koyukuk River drainage, and twinning rates were

historically very high. Utilize memos to archive details of surveys and keep management reports concise. TCA surveys and twinning surveys should be outlined as independent activities in the operational plan.

Table 9. Units 24A and 24B combined moose aerial twinning surveys in the Kanuti–Alatna–Middle Fork Koyukuk rivers, Interior Alaska, regulatory years[a] 2010–2013.

Regulatory year	Cows w/o calves	Cows w/1 calf	Cows w/twins	Twinning %[b]	Yearlings	Dates
2010[c,d]	n/a	34	20	37	n/a	31 May–2 Jun
2011[c]	n/a	25	27	52	n/a	31 May–2 Jun
2012[c]	27	28	21	43	n/a	30 May–1 Jun
2013	n/a	26	19	42	n/a	29 May–2 Jun

[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 twins.
[c] Sample from radiocollared cows.
[d] Including 1 cow with 3 calves.

Table 10. Unit 24D moose aerial twinning surveys in the combined areas of Huslia Flats and Treat Island areas, Interior Alaska, regulatory years[a] 2010–2014.

Regulatory year	Cows w/o calves	Cows w/1 calf	Cows w/twins	Twinning %[b]	Yearlings	Dates
2010	34	38	15	28	24	28 and 29 May
2011	74	47	13	22	14	29 and 30 May
2013	46	57	12	17	18	30 and 31 May
2014	55	27	24	47	14	25 and 26 May

[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 twins.

2. Mortality–Harvest Monitoring and Regulations

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

Data Needs

Harvest estimates are needed to establish that the population is not being harvested in excess of sustained yield. 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

Moose harvested by hunters were reported on report cards to monitor harvest. Data were archived in WinfoNet's moose database and accessed 19 May 2015. This included data from report cards, the harvest ticket hunt, and from drawing and registration permit hunts. Hunters

received up to 2 reminder letters if we did not receive timely harvest reports. Hunters with registration or drawing permits were also reminded to report by email or telephone. Harvest is reported by regulatory year. Information recorded for each moose included date of kill, name of hunter, specific location of kill, method of take and transportation, sex of the moose, and antler measurements. Ages of harvested moose primarily come from hunters passing through the Koyukuk checkstation, as determined by counting cementum annuli of a tooth (Matson et al. 1993) extracted from those moose. We summarized data on hunter residency, hunter success, harvest chronology, and transport methods.

Unreported harvest was estimated from ADF&G-Subsistence Division reports (Brown et al. 2004), historical information, and public interviews (Table 11). The calculated proportional under-reporting between subsistence harvest estimates (Brown et al. 2004) and report card reporting from those years contributes the largest portion of the unreported estimate (RY97–RY99, RY01, RY02; Huslia 5-yr $\bar{x}$ = 72% unreported, Allakaket 5-yr $\bar{x}$ = 81% unreported; Unit 24 combined $\bar{x}$ = 76% 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 late harvest reports. In Stout 2006 the total estimated unreported harvest was 145 moose. Because no new information was available to change that estimate, a constant of 145 unreported moose continues to be used. Because that calculation included some level of ceremonial or potlatch harvest, known harvest for those uses was subtracted from the 145 moose constant for the annual estimate (RY10–RY14). Potlatch, ceremonial, and cultural, and education permit harvest area 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 and backed-up on the Fairbanks H:\ drive and in a WinfoNet moose database.

Table 11. Unit 24 moose harvest by hunters, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory year	Harvest by hunters				Unreported harvest[b]	Potlatch/ Stickdance[c]	Total
	Bull	Cow	Unk	Total			
2010	179	0	2	181	143	2	326
2011	158	0	1	159	141	4	304
2012	190	0	4	194	139	6	339
2013	158	0	0	158	140	5	303
2014	185	0	0	185	138	7	330
2015[d]	174	0	0	174	142	3	319

[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-Subsistence Division's door-to-door survey and other sources.
[c] Includes reported potlatch, stickdance, ceremonial, and cultural permit harvest.
[d] Preliminary data.

Results and Discussion

Harvest by Hunters

Annual reported harvest during RY10–RY14 averaged 175 moose (159–194, Table 11). Harvest reported under potlatch, ceremonial, and cultural, and education permits averaged

4.8 moose/year during RY10–RY14. Typically, 60–70% of ceremonial and unreported harvest was cows.

Illegal and unreported harvests by local residents continued to hamper our efforts to manage moose. During some years, I estimated unreported harvest was nearly equal to the harvest reported on harvest ticket and permit hunt reports (Table 11). Moose taken during winter were rarely reported, even when the season was open. Some villages have never had a license vendor, which contributed to the problem of people hunting without licenses, harvest tickets, or permits.

Federal harvest during RY00–RY03 averaged 4.8 moose/year, increased to 13.6 moose/year during RY04–RY08, 11 moose in RY09, and 0 moose in RY10 (Stout 2014a). At the time of this report no federal harvest data from Unit 24 were available for RY11–RY14. There were 4 federal moose hunts in Unit 24 (FM2402, FM2403, FM2405, and FM2406). Federal harvest data we received prior to RY11 were incomplete, and reporting requirements and data entry protocols were not comparable to our methodology. As the sustainable harvest of moose in Unit 24 is reallocated to federal hunts, the number of moose available to state permitted hunts will have to be reduced.

Permit Hunts

There were 6 drawing hunts in the Koyukuk CUA (DM823, DM825, DM827, DM828, DM829 and DM830; Table 12), 2 outside the Koyukuk CUA in Unit 24C and 24D (DM892 and DM896; Table 13), and 2 registration permits (RM832 and RM834). Results of the RM834 permit are reported in the Unit 21D report (Stout, *In prep*). Results of the RM833 winter registration hunt are reported in Table 14. The results of the 2 drawing hunts in Unit 24A (DM920 and DM922) are reported in Table 15. Hunter success rates for the 2 Dalton Corridor hunts were low at 17% north of Slate Creek (DM920) and 12% south of Slate Creek (DM922) because they are “archery only” restricted use hunts (Table 15).

Hunter Residency and Success

Assessing harvest success rate trends has become increasingly problematic in Unit 24 since RY04 because hunters may obtain and report on multiple reporting mechanisms. Based on harvest reports, the average annual number of moose hunters was 426 during RY10–RY14; most were Alaska residents (Table 16). The number of hunters was probably underreported because Unit 24 residents often did not report unsuccessful hunt information. This became especially apparent beginning in RY04, when failure-to-report regulations were implemented. According to the failure-to-report regulations, hunters who failed to report were cited and barred from obtaining any drawing or registration permits during the following regulatory year.

Harvest Chronology

Over 95% of reported harvest occurred in the September hunting seasons (Table 17). During RY10–RY14 reported harvest averaged 45% in the first half of September and averaged 55% in the second half of September. However, much of the unreported harvest probably occurred during October–March (Brown et al. 2004).

Table 12. 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 (99)	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	83	17	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 13. Units 24C and 24D Huslia River and Hogatza River drainages 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
DM892	2010	35	29	71	20	8 (100)	0 (0)	0	8
	2011	28	56	44	43	9 (100)	0 (0)	0	9
	2012	22	38	62	41	5 (100)	0 (0)	0	5
	2013	35	38	62	63	5 (100)	0 (0)	0	5
	2014	35	79	21	60	11 (100)	0 (0)	0	11
	2015[b]	35	74	26	46	14 (100)	0 (0)	0	14
DM896	2010	47	56	44	47	14 (100)	0 (0)	0	14
	2011	60	52	48	58	12 (100)	0 (0)	0	12
	2012	60	45	55	33	18 (100)	0 (0)	0	18
	2013	39	50	50	49	10 (100)	0 (0)	0	10
	2014	60	47	53	47	15 (100)	0 (0)	0	15
	2015[b]	60	48	52	58	12 (100)	0 (0)	0	12

[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 14. Units 24B and 24C 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
RM833	2010	21	0	100	62	0 (0)	0 (0)	0	0
	2011	11	0	100	80	0 (0)	0 (0)	0	0
	2012	17	0	100	59	0 (0)	0 (0)	0	0
	2013	8	25	75	50	1 (100)	0 (0)	0	1
	2014	20	22	78	55	1 (50)	0 (0)	1	2
	2015[b]	16	0	100	75	0 (0)	0 (0)	0	0

[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 15. Unit 24A Dalton Highway corridor management 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
DM920	2010	20	36	64	45	4 (100)	0 (0)	0	4
	2011	20	19	81	20	3 (100)	0 (0)	0	3
	2012	20	8	92	35	1 (100)	0 (0)	0	1
	2013	20	0	100	20	0 (100)	0 (0)	0	0
	2014	20	20	80	25	3 (100)	0 (0)	0	3
	2015[b]	20	17	83	40	2 (100)	0 (0)	0	2
DM922	2010	51	8	92	49	2 (100)	0 (0)	0	2
	2011	50	3	97	30	1 (100)	0 (0)	0	1
	2012	50	33	67	46	9 (100)	0 (0)	0	9
	2013	51	3	97	39	1 (100)	0 (0)	0	1
	2014	50	13	87	38	4 (100)	0 (0)	0	4
	2015[b]	50	9	91	36	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 16. Unit 24 moose hunter residency and success, Interior Alaska, regulatory years[a] 2010–2015[b].

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[c] resident	Nonlocal resident	Nonresident	Unk	Total	Local[c] resident	Nonlocal resident	Nonresident	Unk	Total	
2010	71	84	26	0	181	104	118	50	1	273	454
2011	62	68	27	2	159	59	109	29	0	197	356
2012	80	76	35	3	194	72	143	43	1	259	453
2013	67	61	30	0	158	82	130	39	0	251	409
2014	76	63	46	0	185	88	144	42	0	274	459
2015[d]	73	68	32	1	174	54	96	36	0	186	360

[a] Regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Some hunters have up to 3 reporting mechanisms (1 harvest permit and 2 registration permits). Data presented here count each reporting mechanism as one "hunter," in terms of effort.
[c] Unit resident only.
[d] Preliminary data.

Table 17. Unit 24 moose harvest chronology percent by month/day, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory year	Harvest chronology percent by month/day				
	9/1–9/14	9/15–9/25	12/1–12/10	3/1–3/10	*n*
2010	42	58	0	0	178
2011	46	54	0	0	158
2012	51	49	0	0	192
2013	41	59	0	0	152
2014	46	54	0	0	184
2015[b]	44	56	0	0	170

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

Transport Methods

During RY10–RY14, boats continued to be the primary transportation method in Unit 24 because of the extensive river system, lack of roads, and restrictions on the use of aircraft within the 2 CUAs (Table 18). Highway vehicles were used only on the Dalton Highway where it crosses eastern Unit 24. Snowmachines were the main transportation method used during winter, but were likely underreported because most of the unreported harvest occurs during winter.

Other Mortality

A minimum of 374–540 wolves in 57–68 packs (Stout 2012b) and a large population of black bears (*Ursus americanus*) inhabit the middle and southern portions of Unit 24. Grizzly bears (*U. arctos*) are common throughout the montane areas. Predation on moose by wolves and bears was thought to be high, keeping the moose population low throughout much of Units 24A, 24B, and 24C. Annual adult mortality was approximately 7.8% for radiocollared moose in Units 24A and 24B during 2008–2009, higher than values reported by Boertje et al. (2009).

Alaska Board of Game Actions and Emergency Orders

Drawing and registration permit hunts continue to be the predominant regulatory feature of Unit 24. Key issues we attempted to manage with regulation changes were declining bull:cow ratios and uniform distribution of hunters in Unit 24D. The regulations were designed to improve distribution of hunters around the perimeter of the Koyukuk CUA and to improve success rates of local hunters. It is important for local hunters to have high success rates during the fall hunting seasons, so they can be less dependent on winter hunts when a higher percentage of cows are generally harvested. Regulation changes adopted by the board during RY02–RY08 were reported in Stout (2010).

At the 2010 spring meeting, the Alaska Board of Game (BOG or board) adopted a 15 December–15 April season in portions of Units 24B and 24C, eliminated the 1–10 December season in those areas, and reduced the size of the Kanuti CUA by 298 mi^2. At the 2012 spring meeting, BOG adopted a wolf predation control plan for Unit 24B to improve moose survival.

Intensive Management

All of Unit 24 has a positive finding for intensive management (IM). An IM plan [5AAC 92.124(c)] was adopted by BOG at the 2012 meeting which prescribed wolf predation control to increase moose calf and yearling survival in a 1,360 mi^2 portion of Unit 24B. The IM plan for moose in Unit 24B was developed based on the recommendation of Koyukuk River Fish and Game Advisory Committee and at the request of the board. The IM plan and the operational plan (ADF&G 2012) included information and recommendations from a feasibility assessment prepared by ADF&G (ADF&G 2011) and recommendations by the board following public comment at the March 2011 board meeting. The Unit 24B wolf predation control activities are an experimental treatment to evaluate whether 1) wolf control in a focused area can allow reallocation of moose mortality from predators to humans and 2) whether moose harvest per unit effort is a feasible response metric at low moose density. Under the IM plan, wolf predation control to improve moose survival was initiated in spring 2013. Implementation of the IM plan [5AAC 92.124(c)] is directed by the IM operational plan (ADF&G 2012). An annual report was submitted to the board at the spring 2014 meeting (ADF&G 2014).

Table 18. Unit 24 moose harvest percent by transport method, Interior Alaska, regulatory years[a] 2010–2015.

Regulatory year	Harvest percent by transport method								*n*
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV[b]	Highway vehicle	Unknown	
2010	14	1	74	4	0	0	6	1	180
2011	16	1	69	5	0	1	5	3	159
2012	16	1	72	3	0	1	7	1	191
2013	13	2	80	2	1	1	1	0	157
2014	18	0	74	2	0	0	6	0	185
2015[c]	12	1	82	1	0	1	3	0	173

[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.

Recommendations for Activity 2.1

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 the lack of population estimates throughout Unit 24 and the generally poor harvest reporting rates.

ACTIVITY 2.2. Develop programs to improve population and harvest data for moose in Unit 24.

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 that data.

Methods

We operated the Koyukuk River moose hunter checkstation and coordinated with Huslia, Hughes, and Allakaket community permit vendors to distribute and collect harvest report cards. Permit hunts in the Koyukuk CUA require checking in at the department-operated checkstation, the Huslia permit vendor, or the Hughes permit vendor. In addition to the permit overlays and report cards, hunter roll sheets tracked hunter success and check-in dates. Moose teeth are collected at the checkstation for aging (Matson et al. 1993). Hunt information and hunter education opportunities are provided at the checkstation (e.g., meat care, landownership, moose biology, predator-prey interactions, reporting procedures).

Results and Discussion

Checkstation results, including the meat evaluation survey and the hunter viewing survey, are found in the RY10–RY14 Unit 21D moose management report (Stout, *In prep*).

Recommendations for Activity 2.2

Continue this activity but modify the objective to include Unit 21D.

3. Habitat Assessment–Enhancement

Browse removal rates were low in Units 24B and 24C (Stout 2010). 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 and backed-up on the Fairbanks H:\ drive and WinfoNet moose database.

Agreements

- Cooperative Agreement, COOP-12-103, Alaska Department of Fish and Game and Allakaket Tribal Council, Disposition of Wolf Carcasses, is found on Galena Office hard drive in the Intensive Management file and backed-up on the Fairbanks H:\ drive and WinfoNet database.
- K'oyitl'ots'ina Limited (KCorp) – Surface Use Access Agreement – 2014, is found on Galena Office hard drive in the Intensive Management file and backed-up on the Fairbanks H:\ drive and WinfoNet database.
- Doyon Limited – Request for Surface Use Access Agreement – 2014, is found on Galena Office hard drive in the Intensive Management file and backed-up on the Fairbanks H:\ drive and WinfoNet database.

Permitting

- The BLM access permit is found on Galena Office hard drive in the Intensive Management file and backed-up on the Fairbanks H:\ drive and WinfoNet database.
- The Institutional Animal Care and Use Committee authorization – 2015 renewal is found on Galena office hard drive in the Veterinary Records file and backed-up on the Fairbanks H:\ drive and WinfoNet database.
- The Commissioner's delegation of authority for predator control – 2015 renewal is found on Galena office hard drive in the Intensive Management file and backed-up on the Fairbanks H:\ drive and WinfoNet database.
- The wolf control operating protocol for intensive management activities in Unit 24B is found on the Galena Office hard drive in the Intensive Management file and backed-up on the Fairbanks H:\ drive and WinfoNet database.
- ADF&G Collection Permit (Glenn Stout #99-014)
- ADF&G Collection Permit (Nathan Pamperin #09-042).

Conclusions and Management Recommendations

Development and initiation of the IM program in Unit 24B was the focus of management activities in Unit 24 during RY10–RY14. The response of the Unit 24B moose population to wolf removal will be monitored by calf and yearling survival of radiocollared moose and GSPE moose surveys. Moose were radiocollared in spring 2012 and each fall during 2012–2015. Harvest and hunter effort in the communities of Alatna and Allakaket will be monitored through household surveys conducted by ADF&G-Division of Subsistence. Additionally, harvest by hunters using permits and harvest tickets will continue to be monitored through the statewide harvest monitoring program. Household surveys were conducted after the September moose seasons in fall RY11–RY15. The wolf predation control program is authorized through RY17.

Without current ADF&G-Division of Subsistence survey data in the remainder of Unit 24, we are not certain if Unit 24 residents met their wild food requirements, but local public comments

suggest those needs were not being met. Predation on moose by wolves and bears was likely the primary factor limiting Unit 24 moose populations. Where predators were lightly harvested for long periods, predation seemed to keep moose densities low (0.1–1.1 moose/mi^2 in areas >800 mi^2; Gasaway et al. 1992).

Completion of the moose telemetry study in Units 24A and 24B was an important accomplishment in RY12, and data from that study has improved our understanding of population dynamics and distribution in this low-density portion of Unit 24.

During RY10–RY14 we completed population estimates for the Koyukuk NWR in central Unit 24D, the upper Koyukuk management area, and Kanuti NWR in Unit 24B. We recommend a high intensity GSPE moose survey in the high density portions of Unit 24D at least once every 5 years to monitor status (Kellie and DeLong 2006; Ver Hoef 2008). Analysis of GSPE data collected in Unit 24B between 1999 and 2015 showed that low intensity surveys conducted in the intervening years of infrequent high intensity surveys provided accurate composition and population estimates and improved the confidence intervals for all survey years when estimates were smoothed. This strategy provided us with better decision-making information for the Unit 24B population than TCA composition and density data alone.

A baseline population estimate for all of Unit 24A should be conducted in cooperation with BLM, and low intensity (100–170 SUs) population estimates of the Kanuti NWR in Unit 24B should be conducted up to 3 of 5 years in lieu of trend count surveys. High intensity population estimation surveys (170–200 SUs) should continue to be conducted once every 5 years on the Kanuti NWR.

My RY14 estimate of 8,601 moose ±1,676 (6,925–10,277), not including an SCF, probably did not achieve the management objective to maintain a population of 10,000–12,000 moose, but the strength of this assessment is debatable. We achieved the objective to provide for moose harvest without exceeding 360 moose (RY10–RY14 average = 321 moose) or a 5% harvest rate (5% harvest rate = 430 moose, RY14 estimated harvest rate = 3.8%). We also achieved the management objective to provide for hunting opportunity that did not exceed 500 hunters.

During RY10-RY14 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 (0.0% in each year during RY11–RY14; Stout, *In prep*). Therefore, the meat care objective was met.

In RY10 and RY14 we did not meet IM population objectives for any of the subunits in Unit 24 (Table 4). The total IM harvest objective, which prescribed at least 500 moose must be made available for harvest, was not achieved. At a 5% harvest rate, a harvestable surplus of only 430 moose was available in RY14.

Because Unit 24D moose populations, harvest patterns, and management objectives are more consistent within Unit 21D, whereas Units 24A, 24B, and 24C are more consistent with one another, regrouping the game management unit reports accordingly may be a change I recommend in the future. 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.

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 management goals will be changed and no longer include the meat spoilage reduction goal. Although meat spoilage was an important concern of the Koyukuk River Moose Hunters Working Group, subjective assessment of harvested moose at the Koyukuk checkstation showed most hunters were properly caring for meat. Additionally, because subjective meat assessment values showed very little variation, we could not detect a change in meat care. Therefore, the following goal will apply to Unit 24 for the next reporting period.

- 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 (5 AAC 99.025)

C1. Unit 24 has a positive finding for customary and traditional uses for moose and amounts reasonably necessary for subsistence uses of 170–270 available moose.

Intensive Management (5 AAC 92.108)

		Moose	
	Unit	Population objective [5 AAC 92.990(63)]	Harvest objective [5 AAC 92.990(35)]
C2.	24A	1,200–1,500	75–125
C3.	24B	4,000–4,500	150–250
C4.	24C	1,000–1,500	50–125
C5.	24D	5,000–6,000	225–425

MANAGEMENT OBJECTIVES

Existing management objectives will be changed to the following.

M1. Maintain a moose population of 11,000 moose.

M2. Provide for an annual harvest of moose not to exceed 360 moose or 5% of the annual moose population estimate each regulatory year.

M3. Provide for moose hunting opportunity not to exceed 500 hunters per regulatory year.

REVIEW OF MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Conduct geospatial population estimation (GSPE) surveys (objectives C1–C5, M1).

Data Needs

RY15–RY19

In cooperation with USFWS and BLM, we plan to conduct GSPE surveys in Unit 24B (Kanuti Refuge), and we need to estimate abundance (90% CI ± 10–30%) to evaluate population status and trend. We need calf:cow ratios (90% CI ± 20–40%) and yearling bull:cow ratios (90% CI ± 20–40%) to evaluate annual productivity and recruitment. We need total bull:cow ratios (90% CI ± 20–40%) to evaluate harvest sustainability.

We need to establish a baseline inventory of the moose population in Unit 24A. We will conduct a GSPE survey to estimate abundance (90% CI ± <20%) during the reporting period if incremental funding is available and it does not compromise completion of the other activities. This is a low priority contingency activity that we will conduct in cooperation with USFWS and BLM.

In cooperation with USFWS, we plan to conduct GSPE surveys in Unit 24D (in combination with Unit 21D), and we need to estimate abundance (90% CI ± <20%) to evaluate population status and trend. We need calf:cow ratios (90% CI ± 15–30%) and yearling bull:cow ratios (90% CI ± 15–30%) to evaluate annual productivity and recruitment. We need total bull:cow ratios (90% CI ± 15–30%) to evaluate harvest sustainability.

Using the subunit estimates, we need to estimate the total Unit 24 moose abundance to calculate harvest rate and harvestable surplus.

Methods

GSPE surveys (see this document "RY10–RY14 Management Report | 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 65% high density:35% low density SU ratio.
- In Unit 24A conduct a high intensity survey (<20% CI, >200 SUs) that includes an aerial stratification if incremental funding is available.
- In Unit 24B alternate high (10–20% CI; 170–200 SUs) and low intensity (20–30% CI;100–170 SUs) surveys with high intensity surveys once every 5 years and 2–3 low intensity surveys during intervening years. Based on historical survey data of the Kanuti survey area, an optimum survey frequency will be evaluated by staff biometricians during RY15–RY19.
- In Unit 24D (in combination with Unit 21D), conduct a high intensity survey (<20% CI; 300–350 SUs), once every 5 years.
- Population estimate (upper range approximations; see page 13) will be compared to the minimum level of the amounts reasonably necessary for subsistence, the midpoint of the IM and management objectives.

ACTIVITY 1.2. Conduct trend count area (TCA) surveys (objectives C1–C5, M1).

Data Needs

RY15–RY19

In cooperation with BLM, we need to assess trend in ratio parameters and plan to conduct a TCA survey biennially in the Unit 24A Middle Fork TCA. In cooperation with USFWS, we need to assess trend in ratio parameters and plan to conduct TCA surveys annually in Unit 24D Huslia Flats and Treat Island 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. If USFWS or BLM are unable to continue cooperative survey efforts, we will reexamine the viability of this activity.

Methods

TCA survey methods (see this report "RY10–RY14 Management Report | 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 24A, in cooperation with BLM, conduct an aerial survey of the Middle Fork TCA (22 SUs; 113.6 mi^2) biennially.
- In Unit 24D, in cooperation with USFWS, conduct an aerial survey of the Huslia Flats TCA (26 SUs; 142.3 mi^2) and the Treat Island TCA (30 SUs; 163.3 mi^2) every year.
    - In Unit 24D, the midpoint estimate of the bull:cow ratio for the Koyukuk CUA will be compared to the management objective of 30 bulls:100 cows (Stout 2014b). The Huslia Flats and Treat Island TCAs will be combined with the

Koyukuk River mouth, Three Day Slough and Dulbi River mouth TCAs in Unit 21D and analyzed as the Koyukuk CUA Core-5 TCAs (Stout 2014b).

ACTIVITY 1.3. Conduct spring twinning surveys in Unit 24D (objectives C1–C5, 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 sustained yield basis of the long-term and to protect moose habitat.

Methods

RY15–RY19

Twinning surveys (see this report "RY10–RY14 Management Report | Population Status and Trend | Methods | Spring Twinning Surveys"). 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 24B, observe a minimum of 50 cows with calves in the Treat Island/Huslia Flats/Dulbi Slough areas (90% CI ± <40%).

ACTIVITY 1.4. Conduct an age structure analysis in Unit 24D, in combination with Unit 21D (Koyukuk CUA) (objectives C1–C5, M1).

Data Needs

Using moose teeth ages from hunter-harvested moose and aerial 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 may supplement a lack of aerial survey data in years of fiscal constraints or refine our assessment of aerial moose surveys that were conducted.

Methods

RY15–RY19

Research age structure modeling techniques and analyze moose age data from hunter-killed moose in cooperation with biometric staff. Investigate funding options and contracting services to complete this analysis.

2. Mortality–Harvest Monitoring

ACTIVITY 2.1. Monitor hunter use levels in the Koyukuk River drainage (objectives C1–C5, M2, M3).

Data Needs

No change from the prior reporting period. Harvest estimates are needed in order to establish that the population is not being harvested in excess of sustained yield. Harvest data from a moose database in 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

RY15–RY19

Harvest data collection and data management are described (see this report "RY10–RY14 Management Report | Mortality-Harvest Monitoring and Regulations | Methods"). The harvest objective is 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 145 moose (minus reported ceremonial or potlatch harvest) to adjust for the unreported harvest. The estimated unreported harvest is based on ADF&G-Subsistence Division household surveys, historical survey and inventory reports, and any other sources that may contribute to developing a minimum harvest estimate. The 145 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.

Using the Unit 24 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 low 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 will be sought to verify and, if needed, refine these methods prior to conducting this activity to ensure that high scientific standards are retained in methods and interpretation of results.

ACTIVITY 2.2. In combination with 21D, develop programs to improve population and harvest data for moose in Koyukuk River Drainage (objectives C1–C5, M2, M3).

Data Needs

Like activity 2.1, harvest data from a moose database in WinfoNet is 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 that data.

Methods

RY15–RY19

No change from previous reporting period. We will continue to operate the Koyukuk River moose hunter checkstation. We will cooperate with Huslia, Hughes, and Allakaket community permit vendors to distribute and collect harvest report cards.

3. Habitat Assessment–Enhancement

No change from prior reporting period. Browse removal rates were low in Units 24B and 24C (Stout 2010). No activities are anticipated or recommended.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Data Recording and Archiving

- GSPE/TCA Moose Survey Form (Appendix A).
- Stratification Flight Survey Form (Appendix B).
- Moose Twinning Survey Form (Appendix C).

Global Position System (GPS) location data will be logged using WGS 84 datum. GPS files will be stored weekly 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 network drive, S:/Stout/Moose/[year]. The "D" drive of the Galena Area Biologist's hard drive will be backed up weekly onto the Area Biologist's network (H) drive.

Hardcopies of species wildlife management reports and plans and the intensive management operational plan for Moose – Unit 24 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, memos, and reports will be stored in the WinfoNet – Data Archive. Project Title: Moose Management Program. Project ID: GMU 24. Primary Region: Region III.

Agreements

Same as listed in the report section.

Permitting

Same as listed in the report section.

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♦ ♦ ♦

Appendix A. Geospatial population estimation and trend count area moose survey form, Alaska.

MOOSE SURVEY FORM

Page ___ of ___ Form MC2 10/31/11

SEARCH IDENTIFICATION

Date: _____ SU #: _____
GMU: _____
Location: _____
Observer: _____
Pilot: _____
Aircraft Type: _____ Temp (F) _____

SEARCH TYPE

☐ Standard ~8 min/mi² (depends on terrain)

Strata: _____
Area (mi²): _____

SEARCH TIMES (in minutes)

Standard
Stop@ _____
Start@ _____
Elapsed _____

OVERALL SURVEY RATING: ☐ Excellent ☐ Good ☐ Fair ☐ Poor

SEARCH CONDITIONS

SNOW AGE

☐ 1. Fresh
☐ 2. < 1 week
☐ 3. >1 week

LIGHT TYPE

☐ 1. Bright
☐ 2. Flat

SNOW COVER

☐ 1. Complete
☐ 2. Some Low veg Showing
☐ 3. Bare Ground Showing

LIGHT INTENSITY

☐ 1. High
☐ 2. Medium
☐ 3. Low

PREDOMINANT HABITAT TYPE IN SU

☐ 1. Open lower elevation, predom shrub, riparian, or wetland
☐ 2. Mixed Open Forest with some shrub understory
☐ 3. Dense Spruce Forest
☐ 4. Dense Deciduous Forest Birch, Aspen, etc. Few Shrubs
☐ 5. Subalpine Shrub
☐ 6. Burn
☐ 7. Other (describe):

CHECK ADDITIONAL CONDITIONS THAT MAY HAVE AFFECTED THE QUALITY OF THE SEARCH

☐ Classification Errors
☐ Uncooperative Pilot
☐ Inadequate Search Effort
☐ Short on Fuel
☐ Windy/Turbulent
☐ Other (Explain):
☐ Inadequate Snow Cover
☐ Inexperienced Pilot
☐ Movement In/Out Of Intensive
☐ Movement In/Out of SU
☐ Improper Aircraft
☐ Poor Light
☐ Inexperienced Observer
☐ Too Many Moose in Intensive (>15)
☐ Observer Airsick
☐ Low Clouds or Fog
☐ Poor Visibility/Snow on Trees
☐ Problems finding SU Boundaries
☐ Observer Sleeping

Group No.	Bulls			Cows				MISC		Total Moose	Remarks/Waypoint/Lat-Lon
	Yrlg	Med	Lrg	Cow w/0	Cow w/1	Cow w/2	Cow w/3	Lone Calf	Unk		
1.											
2.											
3.											
4.											
5.											
6.											
7.											

Group No.	Bulls			Cows				MISC			Remarks/Waypoint/Lat-Lon
	Yrlg	Med	Lrg	Cow w/0	Cow w/1	Cow w/2	Cow w/3	Lone Calf	Unk	Total Moose	
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Appendix B. Moose survey form.

Moose Survey - GMU_____ **STRATIFICATION FLIGHT** 20xx
Observers_____
Pilot_____ Date_____ Time_____
Conditions_____

Int ID	STRAT	Tracks	Habitat	Moose	Comments

Appendix C. Moose twinning survey form.

Moose Twinning Survey Form

Page____of____

GMU_____ Area_____ Date:_____ Stop:_____

Pilot:_____ Observer:_____ Start:_____

Survey Conditions: Clear:_____ Overcast:_____ Broken:_____ Time:_____

Wind:_____ Turbulence: None Light Moderate

Lake Ice Present: None Some Most Snow Patches: None Other_____

Leaf-out Condition: Willow_____(%) Birch_____(%) Cottonwood_____(%) Larch_____(%)

River Water Level: High Medium Low Flood Conditions: Yes No

Obs. #	Wpt	Cow + 1 calf	Cow + 2 calf	Other		Talley/Comments
1					COWS	
2						
3						
4					YEARLINGS	
5						
6						
7					BULLS	
8						
9						
10						
11						
12						
13						
14						
15					Gr. Bears	
16						
17					BL. Bears	
18						
19					Wolves	
20						
21					Other	
22						
TOTAL						


ALASKA
DEPARTMENT OF FISH AND GAME