Species Management Report and Plan ADF&G/DWC/SMR&P–2018–15

Moose Management Report and Plan, Game Management Unit 6:

Report Period 1 July 2010–30 June 2015, and

Plan Period 1 July 2015–30 June 2020

Charlotte Westing

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Alaska Department of Fish and Game Division of Wildlife Conservation

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

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

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

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

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Purpose of this Report

This report provides a record of survey and inventory management activities for moose in Unit 6 for the 5 regulatory years (RY) 2010–2014 and plans for survey and inventory management activities in the following 5 regulatory years, 2015–2019. A regulatory year (RY) begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011). This report is produced primarily to provide agency staff with data and analysis to help guide and record its own efforts but is also provided to the public to inform it of wildlife management activities. In 2016 the Alaska Department of Fish and Game's (ADF&G) Division of Wildlife Conservation (DWC) launched this 5-year report to more efficiently report on trends and describe potential changes in data collection activities over the next 5 years. It replaces the moose management report of survey and inventory activities that was previously produced every 2 years.

I. RY10–RY14 Management Report

Management Area

Unit 6 covers approximately 10,140 mi^2 of land including Prince William Sound, the Copper River Delta, and the North Gulf Coast of Alaska (Fig. 1). Unit 6 is divided into 4 administrative units (6A, 6B, 6C and 6D.) Moose did not occur in meaningful numbers prior to their introduction, likely due to physical barriers to migration. Terrain includes rugged mountains, old-growth forest, coastal wetlands, and muskeg meadows.

Summary of Status, Trend, Management Activities, and History of Moose in Unit 6

Moose populations in most of Unit 6 originated from translocations of calves from the Kenai Peninsula, Anchorage, and the Matanuska–Susitna area (Paul 2009). The only moose endemic to this unit are small populations in the Lowe River drainage in Unit 6D, which probably number about 40 animals total. Until sometime within the last 70 years, glaciers isolated the Copper River Delta (CRD) from moose populations in other parts of the state. Many people recognized the CRD contained good moose habitat.

During 1949–1958, Cordova residents successfully raised 24 captive moose calves and released them on the western CRD (Unit 6C). This small population grew rapidly and expanded eastward across the Copper River and into the Martin River Valley (Unit 6B) by the early 1960s. Eastward expansion continued into the Bering River area (Unit 6A) by the late 1960s and to Cape Yakataga by the mid-1970s. Meanwhile, the 1964 Good Friday Earthquake led to uplift by as much as 11.5 meters (38 feet) in areas of Unit 6. The CRD itself uplifted 1.8–3.4 meters (5.9–11.2 feet), effectively changing the habitat from a subtidal estuary to intertidal and supertidal wetlands that are gradually transitioning from willow to alder. These changes may be decreasing available moose habitat and habitat quality (Stephenson et al 1998). Habitat has been mechanically altered nearly annually since the 1990s by the U.S. Forest Service (USFS) and the Native Village of Eyak (NVE) through hydro-axing alder stands to reinitiate habitat succession.

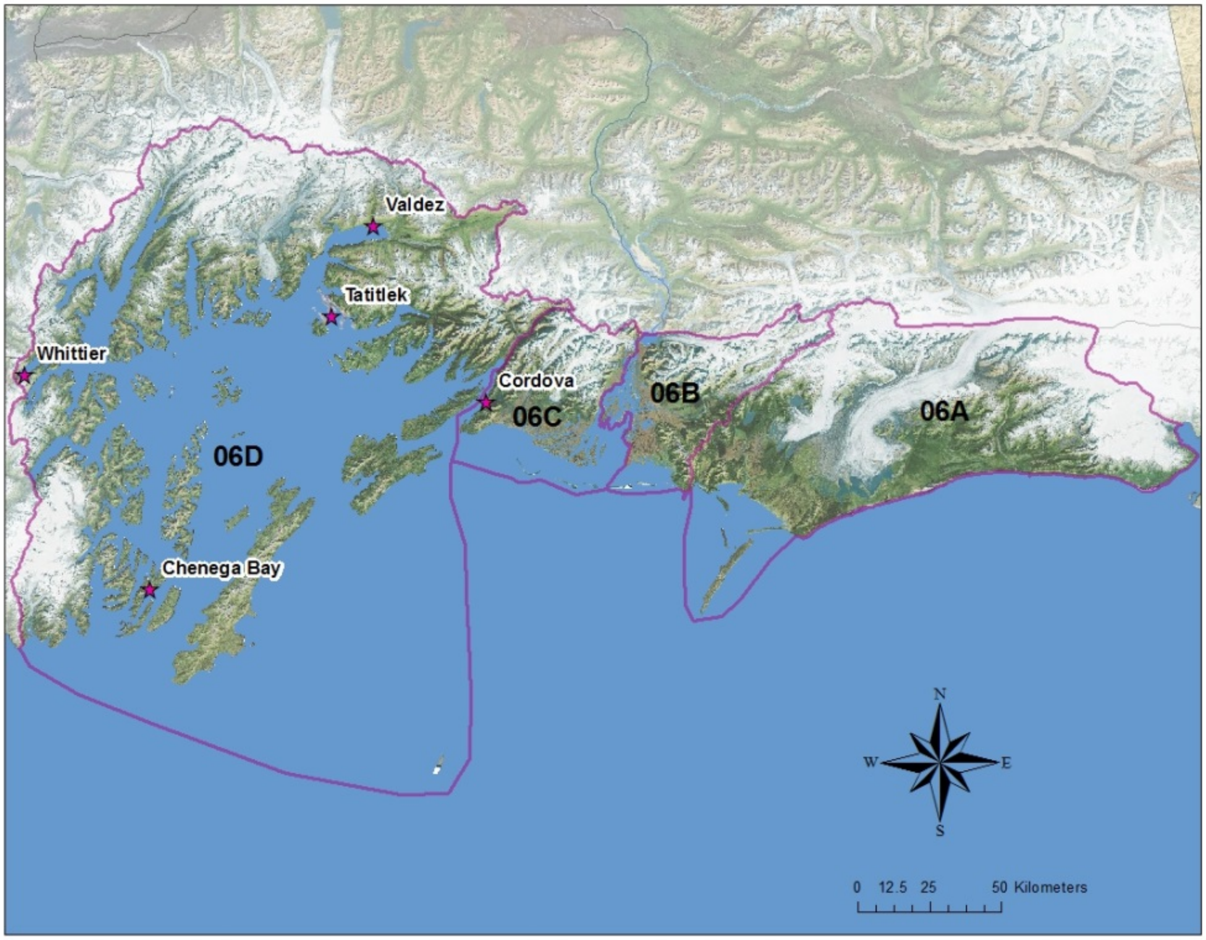

Figure 1. Map showing the boundaries of Unit 6, Alaska.

The CRD was evaluated in the early 1990s for nutritional carrying capacity (MacCracken 1992, MacCracken et. al 1997). The carrying capacity estimate encompassed a wide range (380–1,424 moose, depending on winter snow depths). In the early 1990s, population estimation techniques transitioned from minimum count techniques to the Gasaway estimation technique (Gasaway et al. 1986). Nowlin (1995) revised harvest objectives in 1994 using this new information about carrying capacity of the winter ranges and better estimates of population size.

The population reached a high of approximately 1,600 in 1988 as the population came out of its irruptive period (Griese 1990). Population objectives were relatively conservative in the 1970s and early 1980s because of concerns about mortality during severe winters. Objectives were established at 0.9–1.2 moose/mi^2 after a severe winter in 1971–1972 and remained conservative under management plans written in 1976 (ADF&G 1976).

Hunting of the introduced population in Unit 6C began with 25 bulls harvested in 1960. Harvest began in Unit 6B during 1965 and Unit 6A during 1971. In 1977, moose in Unit 6A were designated as 2 populations (east and west of Suckling Hills) and have been managed separately since then.

By 1994, harvest was liberalized to accommodate the interest in increased harvest opportunities (Nowlin 1998). Cow hunts were permitted to prevent post-irruptive collapse. However, since that time, the populations in Units 6B and 6A have declined and stabilized at low numbers that are incompatible with cow harvest. The last year of cow harvest in Unit 6B was in 1998 and the last year in Unit 6A was in 2005. Now cow hunts are used in Unit 6C only where moose populations are higher than publicly vetted population objectives.

Hunters harvested more than 5,700 moose from 1965 to 2015 in Units 6A, 6B, and 6C. In contrast, total kill of the endemic moose population in Unit 6D during the same period was approximately 100 moose. The 10-year (RY03–RY12) and 20-year average (RY93–RY12) annual harvest in Units 6A, 6B, and 6C was 120 (Standard Deviation [SD] = 28) and 104 (SD = 29) moose respectively.

The harvest allocation for cow moose in Unit 6C was moved into federally administrated subsistence hunting in 2000, as was 75% of the bull harvest quota in 2002. These changes reflected a positive Customary and Traditional Use finding by the Federal Subsistence Board (FSB) the same year. This increased rural harvest opportunity for Cordova residents from an average 75% under state regulations to more than 90% under combined state and federal regulations.

Management Direction

Existing Wildlife Management Plans

A formal plan for moose management in Unit 6 does not exist. However, current management goals and objectives were formed with thorough consultation with the local Fish and Game advisory council.

Goals

Our goals in Unit 6A East are to take large moose (>50-inch antler spread) and to provide for optimum harvest. For the remainder of Unit 6, the goals are to provide for optimum harvest and to provide for the greatest opportunity to hunt.

Codified Objectives

Amounts Reasonably Necessary for Subsistence Uses

The Alaska Board of Game has not made a positive customary and traditional use determination for moose in Unit 6.

Intensive Management

Moose in Unit 6 have a negative intensive management finding.

MANAGEMENT OBJECTIVES

The management objective for Unit 6A East is to maintain a population of 300–350 moose and a minimum bull:cow ratio of 30:100. The objectives for Units 6A West and 6B are to maintain populations of 300–350 moose and minimum bull:cow ratios of 15:100 in each unit. In Unit 6C, our objective is to maintain a population of 400–500 moose and minimum bull:cow ratios of 25:100 to provide for improved viewing opportunities along the Cordova road system.

MANAGEMENT ACTIVITIES

Methods used for data collection and results for all activities during RY10 are reported in Crowley (2014) and during RY11 and RY12 in Westing (2016).

1. Population Status and Trend

ACTIVITY 1.1. Estimate late winter abundance in at least one survey area annually.

and

ACTIVITY 1.2. Estimate calf recruitment in at least one late winter survey area annually.

Data Needs

Population estimates are necessary to provide maximum harvest without a negative effect on the population.

Estimating calf recruitment may help in anticipating population trajectory and lead to the setting of appropriate harvest rates.

Methods

Population estimates were conducted between mid-January and mid-March. Surveys were dependent on adequate snow cover and an acceptable weather window for survey completion. Study design was based on stratified random sampling with the Gasaway technique from 1991 to 2012. We transitioned to the Geospatial Population Estimate (GSPE) technique in 2013. Sample units were flown at altitudes of 800–1,500 feet above ground level at an intensity of approximately 4–6 minutes per square mile. Sightability Correction Factors (SCFs) were also generated using more intensive surveys (9–12 minutes per square mile). SCFs were applied to the number of moose observed to give an estimate of total observable moose.

Data collected with the Gasaway technique utilized the DOS (Disk Operating System) program MoosePop whereas the GSPE utilizes a combination of the GSPE analysis tool in WinfoNet for the high strata and a standard Gasaway analysis for the low strata (25 March 2014 memo from C. Westing, Area Management Biologist, to G. Del Frate, Management Coordinator, ADF&G Anchorage). WinfoNet is the Division of Wildlife Conservation's intranet data system.

Recruitment of calves is estimated during spring surveys, usually in concert with a population estimate. In RY14, recruitment was estimated using a "minimum count assessment" when snow was inadequate to estimate abundance. Calves are identified based on body size, rostrum length, and proximity to a larger moose. GPS locations are recorded to assess distribution.

Results and Discussion

During this reporting period, GSPE surveys were conducted in RY13, west of the CRD (Unit 6C) and east of the CRD including the Martin River Valley (Unit 6B). No population estimation surveys were conducted in RY14 due to weather (inadequate snow). Results from this reporting period are summarized below. Individual survey reports provide more detail and can be found in Appendices A and B. Surveys will be conducted in Units 6A, 6B, and 6C during the next reporting cycle.

<u>Units 6B and 6C</u>

The RY13 point estimate for Unit 6B, east of the Copper River Delta and including the Martin River Valley, was 227 (90% CI: 177–278; Table 1). All of the results for the last 5 surveys fall within the confidence intervals for this survey. The RY13 estimate is slightly lower than the RY11 estimate of 271 although confidence intervals for these surveys overlap. This population has been below the management objective of 300–350 since 1998 (Fig. 2).

The RY13 point estimate for Unit 6C, west of the Copper River Delta was 609 (90% CI: 483–734; Table 1). This is virtually identical to the previous estimate in RY11 of 601 and is above management objectives (400–500 moose; Fig. 3). Now that a second survey has yielded population estimate of more than 600 moose, concerns that the RY11 estimate was elevated have been largely alleviated.

Calf recruitment was high in the RY13 population estimate. Calf survival in Unit 6C was 20% of observed moose, compared with 15% calves in GMU 6B (east of the Copper River including Martin River drainages).

<u>Unit 6A West</u>

During the RY14 recruitment survey, 160 moose were observed in Unit 6A West, 65% of the last population estimate (RY08) of 245 moose (Table 1; Appendix B). However, with 6 years between data points, it is impossible to know what proportion of the population was truly observed. Twenty of these moose were calves and 140 were adults. Using these numbers, 14 calves:100 Adults (c:A) were observed, a substantial improvement from the last survey of 4 (c:A). Alternatively, we observed 13% calves compared with the last survey which found 3% calves (Appendix B).

Recommendations for Activity 1.1

Continue.

Recommendations for Activity 1.2

Continue performing GSPE surveys. Recruitment surveys with inadequate snow should be conducted with extreme caution.

Table 1. Unit 6, Alaska moose population estimates, regulatory years[a] (RY) 2006–2015.

Unit	Year	Survey date	Calves (%)	Adult Estimate	Population Estimate	90% C.I.	Moose Observed
6A East	RY07	29 Jan 2008	7	213	230	212–247	203
	RY09[b]	02 Feb 2010	-	44	280	-	49
6A West	RY07	31 Jan 2008	7	257	276	249–301	232
	RY08	14 Feb 2009	3	187	245	212–279	194
	RY14[c]	11 Mar 2014	13				160
6B	RY07	18 Jan 2007	6	179	242	225–258	195
	RY09	17 Mar 2010	16	144	172	116–227	122
	RY11	29 Jan 2012	16	204	271	236–307	174
	RY13	19 Feb 2014	15	196	227	177–278	106
6C	RY06	18 Jan 2007	20	447	560	453–667	409
	RY07	14 Jan 2008	15	367	430	389–471	347
	RY08	14 Feb 2009	19	314	388	334–443	269
	RY09	16 Mar 2010	17	245	296	164–426	183
	RY10	23 Feb 2011	17	331	398	324–471	296
	RY11	25 Jan 2012	21	472	601	536–666	535
	RY13	19 Feb 2014	20	487	609	483–734	291

[a] A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Brief survey between Cape Yakataga and Icy Bay east of established survey, colonized by moose and now hunted regularly. These data were added to the survey results for RY08 for the RY09 estimate.
[c] Population estimate not performed due to inadequate snow.

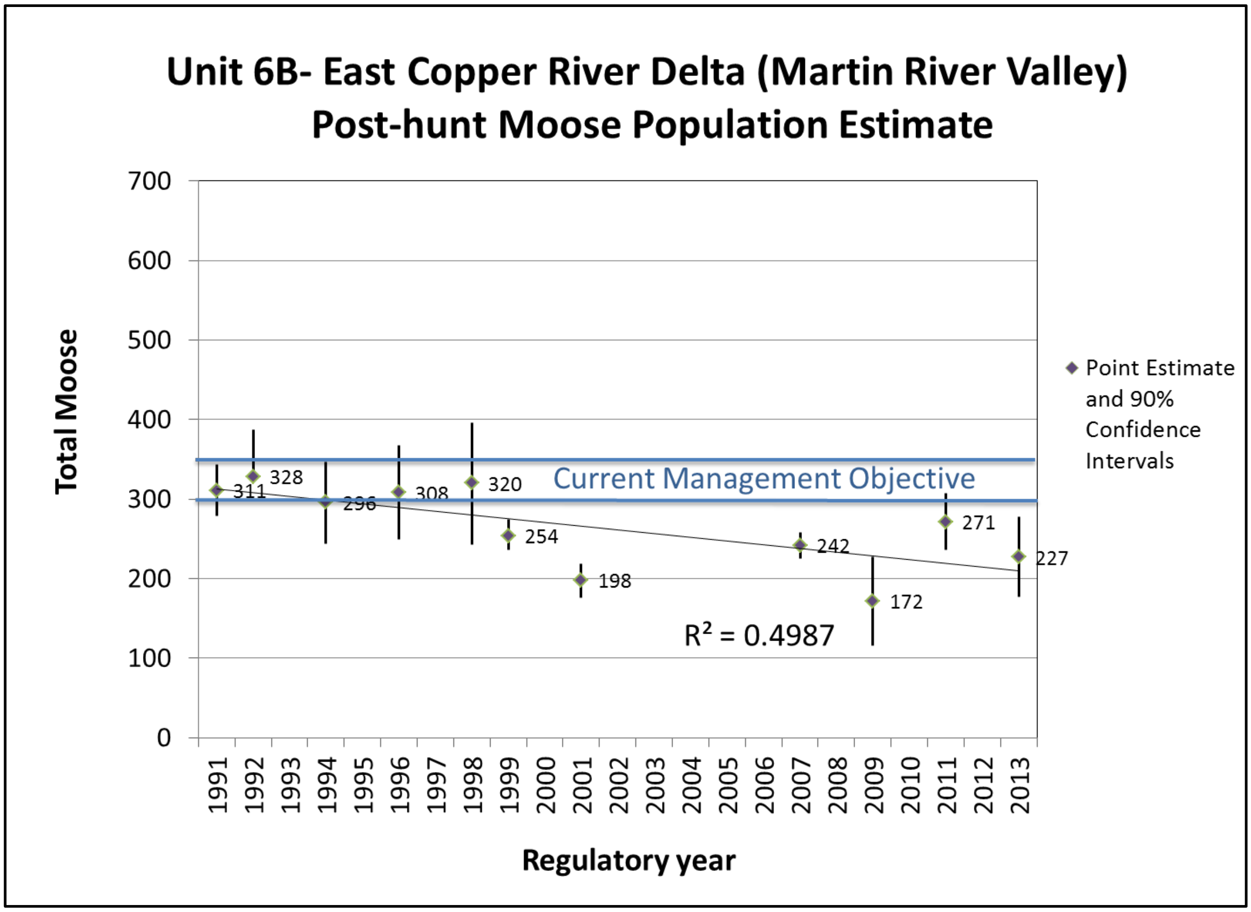

Figure 2. Post-hunt moose population estimates, Unit 6B, regulatory years[a] 1991–2013.

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

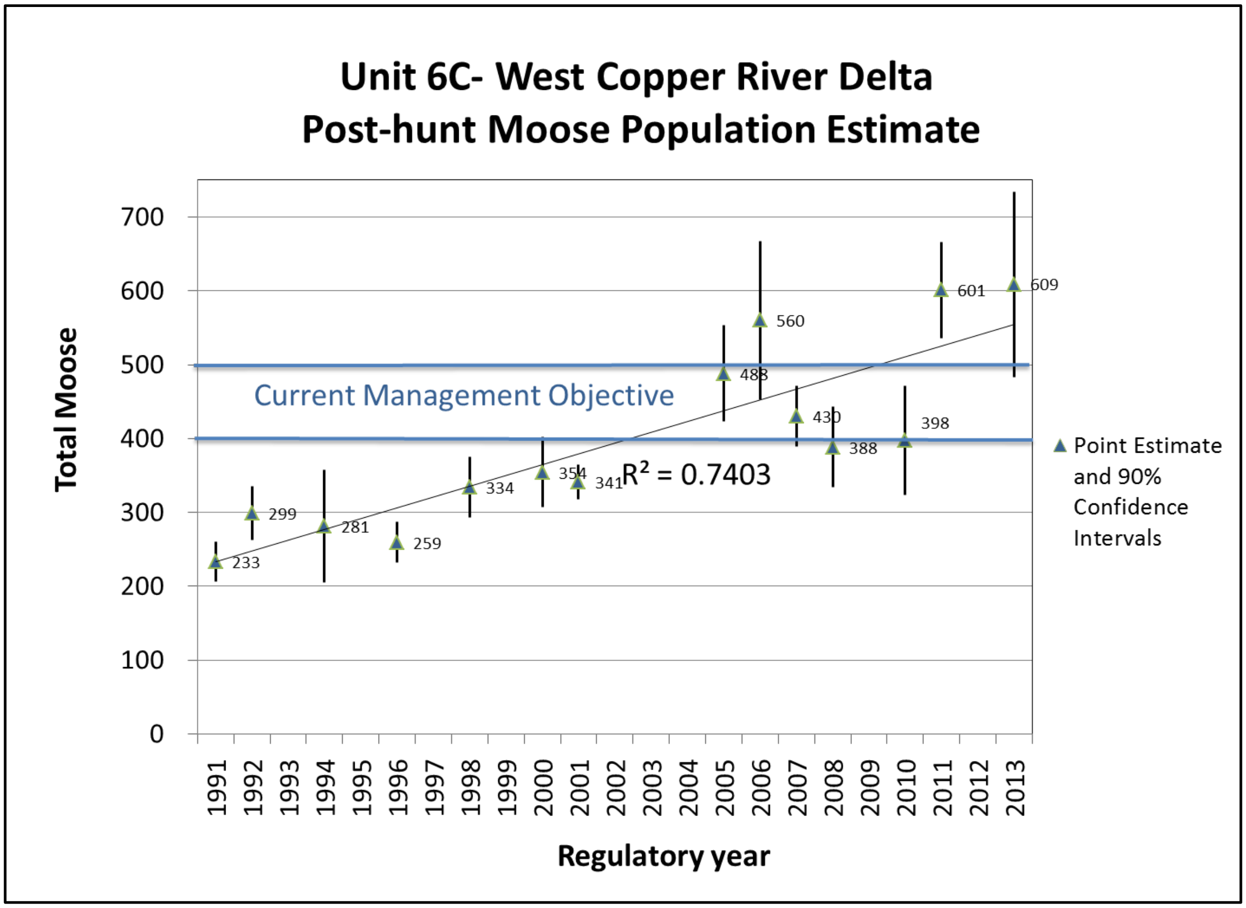

Figure 3. Post-hunt moose population estimates in Unit 6C, Alaska, regulatory years[a] 1991–2013.

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

ACTIVITY 1.3. Estimate fall composition in at least one area annually.

Data Needs

Composition surveys are an essential management tool to calculate appropriate bull harvest quotas and monitor the potential effects of selective harvest. In addition to the ratio of bulls:100 cows (B:C), the ratio of calves:100 cows (c:C) is collected. This metric can be used to understand potential impact of predation and can be used to understand winter mortality when compared with a spring population estimate. Depressed B:C ratios have been found to affect the fecundity of primiparous moose (Solberg et. al, 2002) and have been related to a delay in mean parturition date which may influence the winter survival of calves (Sæther et al., 2003).

Methods

We conduct aerial surveys to estimate fall moose population composition in November when snow increases sightability (Crowley 2010). In some years, requisite snow does not occur by the time antlers begin to shed in early December. Surveys are flown in Piper Super Cub aircraft at between 300 and 800 feet above ground level. Survey techniques in RY13 used a stratified random sample of GSPE survey units (approximately 6 square miles). We used the stratification from the spring population estimate survey to focus effort away from areas that are not expected to have moose. This technique is preferable to unstructured sampling, which can lead to bias toward sampling large groups of animals which are weighted toward more cows than other groups.

Sample units were selected at random in Unit 6C based on the preponderance of high strata. In Unit 6B, sample units were selected using an 80/20 split between high and low strata, respectively, based on most recent spring survey stratification. Sample unit order was determined by a randomly generated order with modifications for weather when necessary. Moose seen in transit or outside of sampled units were also counted and classified but were indicated as such so they could be separated for analysis. Bulls were classified as yearling (spike–fork), medium (<50-inch antler spread), and large (>50-inch antler spread.) Cows were classified as either a cow without calf, cow with one calf, or cow with two calves. Prior to 2009 bulls were classified only as either yearling or >2-year-old. Waypoints were taken for groups of animals to record distribution and determine inclusion in GSPE analysis if deemed appropriate. Observations of other wildlife, including coyotes and bears, were also recorded.

Results and Discussion

Fall composition surveys were completed in RY13 for Unit 6C and RY14 for Unit 6B. Details are available in Appendices C and D.

Unit 6C

During the RY13 fall composition survey in Unit 6C, 255 moose were observed (Tables 2 and 3). Sixty-three of these moose were bulls, 129 were cows, and 63 were calves. Using these numbers, 49 bulls:100 cows (B:C) and 49 calves:100 cows (c:C) were observed.

Table 2. Unit 6, Alaska moose composition estimates, regulatory years[a] 2004–2013.

Unit	Year	Survey Date	Number observed: Bulls	Cows	Calves	Bulls: 100 cows	Calves: 100 cows	Calves (%)	Moose observed
6A West[b]	RY05	5 Dec 2005	26	143	18	18	13	10	187
	RY09	17 Nov 2009	26	129	19	20	15	11	174
6B	RY05	2 Dec 2005	33	77	19	45	25	15	129
	RY14	30 Nov 2014	12	66	24	18	36	24	102
6C	RY05	1 Dec 2005	45	151	44	30	29	18	240
	RY07	30 Nov 2007	32	83	14	36	17	11	129
	RY09	16 Nov 2009	34	230	34	14	15	11	298[c]
	RY10	2 Dec 2010	40	183	35	22	19	14	258
	RY13[b]	2 Dec 2013	63	129	63	49	49	25	255

[a] A regulatory year begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Composition data not collected in 6A East.
[c] Includes1 unknown moose

Table 3. Unit 6C, Alaska composition survey, regulatory years[a] 2009–2013.

Survey date	Yearling bulls	Medium bulls	Large bulls	Bulls >2 yrs	Cows	Calves	Unk	B:C	c: C	Calves (%)	Total
16 Nov 2009	18	9	6	15	230	34	1	14	15	11	298
02 Dec 2010	28	9	3	12	183	35	0	22	19	14	258
02 Dec 2013[b]	13	34	16	50	129	63	0	49	49	25	255

[a] A regulatory year begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Data collected using a modified Geospatial Population estimate (GSPE) for bulls was 64 Bulls:100 Cows (95% CI: 30–97). The GSPE found 50 Calves:100 Cows (95% CI: 17–83)

The GSPE allows for the generation of measures of precision. For the analysis, 192 moose were considered. Using only these numbers, 53 B:C and 49 c:C were observed. The model generated a B:C ratio of 64 with a 95% Confidence Interval of 30–97. The model also generated a c:C ratio of 50 with a 95% Confidence Interval of 17–83. Therefore, all aforementioned scenarios are encompassed by the confidence intervals.

From 2006 through 2009, the bull harvest may have impacted B:C ratios, which were documented as low as 14 B:C in 2009 (Crowley, 2010). Anecdotal evidence reported a drop in the number of bulls in the population and antler spread data also reflected that perhaps fewer large bulls were available for harvest (Fig. 4; Milo Burcham, USFS, Cordova, personal communication). As a result of these data, adjustments were made in quotas to rebuild the bull component of the population. In 2009 and 2010 when bulls were classified into the 3 categories also used in the 2013 survey, there was a preponderance of yearling bulls. However, in 2013,

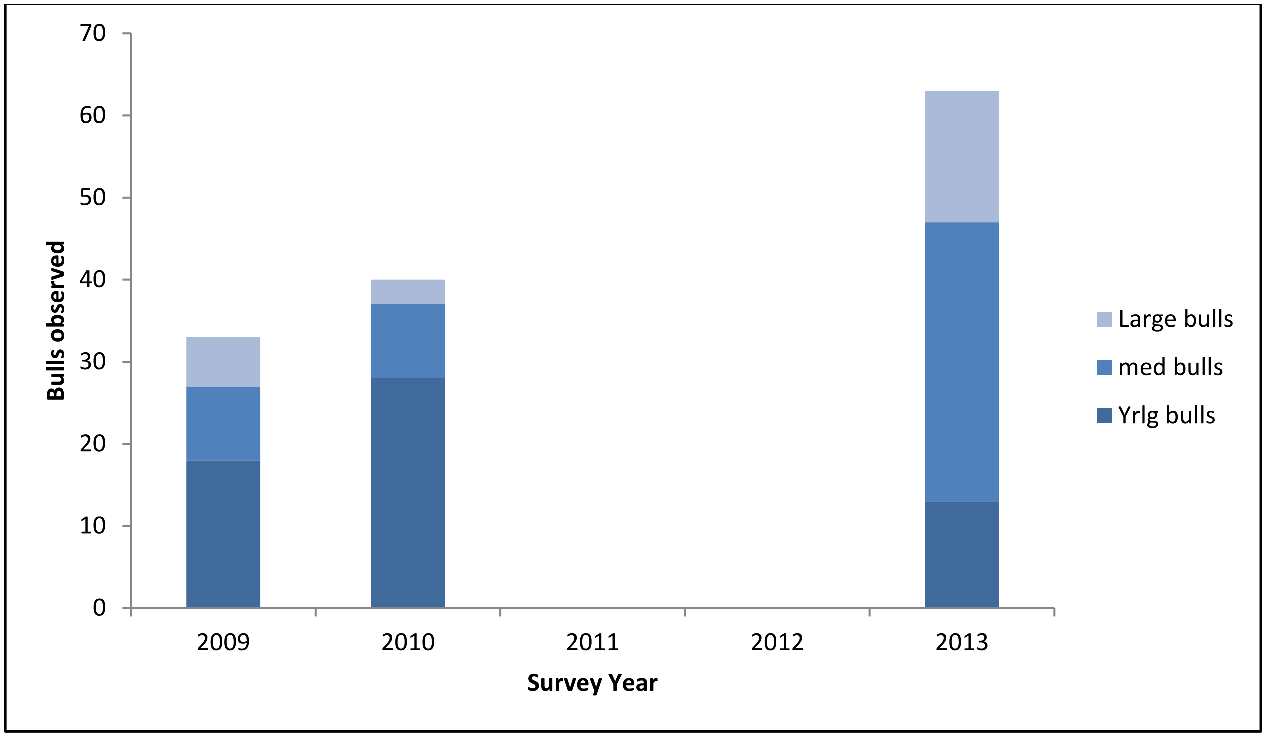

Figure 4. Size distribution of bulls in Unit 6C, Alaska observed during fall composition surveys, regulatory years[a] 2009–2013

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

54% of observed bulls were medium, 25% were large and 21% were yearling bulls (Fig. 4). Calf:cow ratios were the highest observed since the late 1970s when the population was coming out of its irruptive period. Of the cows with a calf at heel, 19% had twins compared with 6% in 2010 and 12% in 2009.

Unit 6B

During the RY14 fall survey in Unit 6B, 102 moose were observed. (Table 2) Twelve of these moose were bulls, 66 were cows, and 24 were calves. Using these numbers, 18 bulls:100 cows (B:C) and 36 calves:100 cows (c:C) were observed.

It is important to note that 75% of the bulls that were observed (nearly all of those in the medium and large categories, Table 4) were one-antlered. This suggests that antler cast may have been premature this year and there is the possibility that some antlerless bulls may have been classified as cows. The extent to which this is the case is unknown. The high number of calves observed relative to cows (36 calves:100 cows) suggests that little misclassification occurred. Previous surveys showed a low proportion of one-antlered bulls (one or two observed per survey). The RY13 composition survey (conducted November 29 and December 2) on the West Copper River Delta had 30% one-antlered bulls.

Table 4. Unit 6B, Alaska composition survey detail, regulatory years[a] 2005–2014.

Survey date	Yearling bulls	Medium bulls	Large bulls	Bulls >2 yrs	Cows	Calves	Unk	B:C	c: C	Calves (%)	Total
02 Dec 2005	9	10	16	26	77	17	0	45	22	13	129
30 Nov 2014	3	7	2	9	66	24	0	18	36	24	102

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

This early antler cast observation seems a very significant departure from the norm. A standard parameter for fall survey completion is a December 1 deadline which should avoid most early antler cast. Classifications of over 30,000 moose using aerial surveys in Canada have never found such early antler casting (Dr. Vince Crichton, personal communication). Moose surveys conducted over many years in Alaska have also never turned up significant early antler cast (Jim Dau, Kris Hundertmark, Jeff Selinger, and John Crouse, ADF&G and former ADF&G biologists, personal communications). Those moose that lose antlers prematurely are expected to be in the large (>50-inch) category. In the case of this survey, all of large bulls classified had just one antler but 85% of the medium bulls (greater than spike-fork but less than 50-inch antler spread) were also one-antlered. Because surveys in this area have not been performed at regular intervals or with much frequency, there is simply too little data to attempt to understand if early antler cast is regularly observed or variable related to annual conditions.

While little is known about factors that influence antler cast, it is largely thought to be influenced by photoperiod and nutrition. Moose on the Copper River Delta appear to have a higher than expected rate of abnormal antler formation. It has also been observed that a high proportion of antler sheds retained a portion of the pedicle bone. MacCracken et al. 1994 explored factors influencing observed “peculiar” antler cast. MacCracken et al. tested antler sheds for differences in iron (Fe) and Phosphorus (P) between antlers with or without retained pedicle bone. They found significant differences between these groups and thought it might be related to the availability of these elements in aquatic vegetation. These minerals were thought to influence the density and strength of the bone. This has never been further tested except to further document the retention of the pedicle bone on shed antlers. The number of bulls in this area may indeed by lower than in 2005 when 45 bulls:100 cows were observed. From 2004 through 2010, the bull harvest may have been too liberal, as harvest rates exceeded 10% in all years (13% average). Antler spread data as reported on permit reports indicates a decreased average antler spread for the last 4 years (Fig. 5).

Calf:cow ratios were the highest observed since the late 1970s when the population was coming out of its irruptive period. This suggests that the despite the low number of bulls observed, cows are being bred. Of the parturient cows, 9% had twins compared with 14% in 2003 and 13% in 2005. Random sample unit selection addressed the potential for bias in the 2014 survey with respect to which areas were examined for moose. Prior to 2014, data were collected by minimum count with a goal to classify at least 100 moose. Minimum count techniques of the past may have been biased against finding calf–cow groupings and biased towards larger congregations of

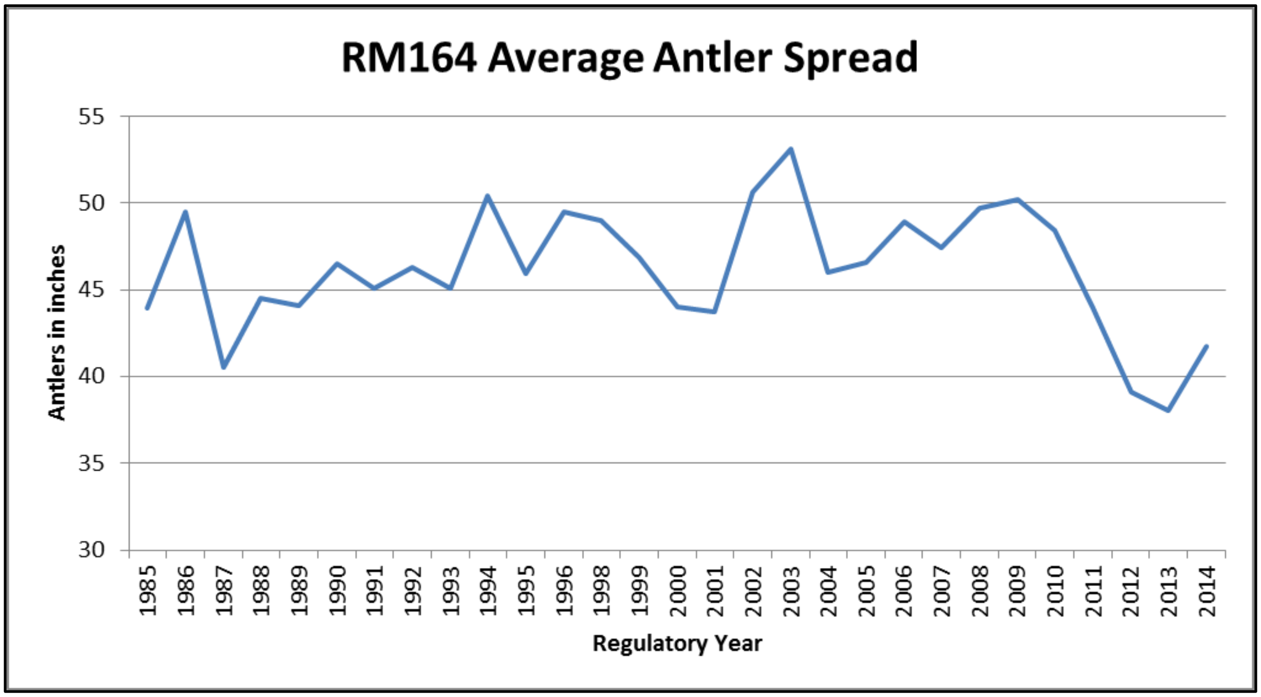

Figure 5. Self-reported antler spread in the Unit 6B, Alaska hunt, regulatory years[a] 1985–2014.

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

moose. The possibility also exists that more calves were produced this year. The high calf:cow ratio suggests that a large number of bulls were not misclassified.

Recommendations for Activity 1.3

Continue with careful attention to observing and documenting single or no antlered bulls.

2. Mortality–Harvest Monitoring and Regulations

ACTIVITY 2.1. Monitor mortality and harvest in Unit 6 annually.

Data Needs

Annual summaries of harvest are needed to establish Maximum Allowable Harvest (MAH) for sustained yield.

Methods

Harvest data come from hunt reports, a mandatory condition of drawing and registration permits. These data are summarized by subunit, except for Unit 6A, which was divided into eastern and western portions. The eastern portion encompassed all drainages into the Gulf of Alaska between Cape Suckling and the head of Icy Bay. The western portion encompassed all drainages into the Gulf between Cape Suckling and Palm Point. Harvest data were summarized by regulatory year (RY).

We monitor harvest using the WinfoNet harvest database to track and store records on permit issuance and hunt reports.

Season and Bag Limit

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
<u>*RY13 and RY14*</u>		
Unit 6(A), all drainages into the Gulf of Alaska from Cape Suckling to Palm Point		
1 bull moose	1 Sep–30 Nov (registration hunt)	1 Sep–30 Nov (drawing permit only)
Remainder of Unit 6(A)		
1 bull with spike-fork antlers or 50-inch antlers or with 3 or more brow tines on 1 side	1 Sep–30 Nov (general hunt)	
1 bull with 50-inch antlers or antlers with 3 or more brow tines 1 side		1 Sep–30 Nov (general hunt)
Unit 6(B)		
1 antlered moose by registration permit only	1 Sept–31 Oct (registration hunt)	No open season
Unit 6(C)		
1 bull	1 Sep–31 Oct	No open season
Unit 6(D)		
1 bull moose	1 Sep–30 Sep	1 Sep–30 Sep

Unit 6B is a controlled use area. No motorized vehicles are allowed for transportation 15 August–4 September, except for highway vehicles on the maintained surface of the Copper River Highway. Therefore, the first 4 days of the season were open to nonmotorized hunting only. Similar to the "no same-day airborne" regulation, after 4 September moose cannot be taken until after 3 a.m. following the day on which a motorized vehicle was used for transportation off the highway. This required motorized hunters to camp out before harvesting a moose, which slowed harvest, extended the season, and allowed more hunters to participate. All airboats are required to display an Alaska Department of Fish and Game identification number.

Results and Discussion

Harvest by Hunters

Reported moose harvests for Units 6A of 29 and 30 for RY13 and RY14, respectively, (Table 5) were below both the 10-year average (RY03–RY12) of 33 moose and the 20-year average (RY93–RY12) of 41 moose. This may be an indication of population levels but is likely related to weather and commercial operator dynamics. Harvest in Unit 6B was normal during this reporting period, with 22 and 20 moose taken in RY13 and RY14, respectively, compared with the 10-year average (RY03–RY12) of 23 moose and the 20-year average (RY93–RY12) of 20 moose. In Unit 6C, the RY13 harvest of 76 moose was higher than the 10-year average of 65 moose and the 20-year average of 46 moose. However, the maximum allowable harvest (MAH) in RY13 was increased in response to the population exceeding its management objectives. The harvest for RY14 was 79 moose. Harvest in Unit 6D was typical compared to previous years, with only a few animals taken each year.

Permit Hunts

During this reporting period, Unit 6A West had 1 registration and 1 drawing permit hunt, Unit 6B had 1 registration hunt, and Unit 6C had 1 state drawing hunt. Also, in Unit 6C, there were 2 federal subsistence hunt (antlerless and bull) and 1 potlatch bull permit each year (Table 6).

Hunter Residency and Success

Unitwide, hunter success ranged 33–55% during the years of this reporting period (Table 7). This success rate is higher than the 10-year average (RY03–RY12) of 42% and the 20-year average (RY93–RY12) of 40%. Local residents composed 81% (RY13) and 79% (RY14) of successful moose hunters in Unit 6 during this reporting period (Table 7). Since 2001, all the cow harvest and 75% of the bull permits in Unit 6C have been administered through the federal system by the U.S. Forest Service, Cordova Ranger District, which requires Cordova residency. This provided a 77–79% annual rural allocation for Cordova residents during the reporting period. Resident-only seasons and difficult access on the Copper and Bering River deltas discouraged nonlocal hunters from participating in hunts in Units 6B and 6A West. Almost all nonresident hunting occurs in Unit 6A East. Most nonlocal Alaska residents either successfully draw for a permit in Unit 6C or they hunt in the Unit 6B registration hunt.

Table 5. Unit 6, Alaska moose harvest, regulatory years[a] 2010–2014.

		Reported Harvest				
Unit	Year	Males	(%)	Females	(%)	Total[b]
6A East	RY10	18	(100)	0	(0)	18
	RY11	19	(100)	0	(0)	19
	RY12	7	(100)	0	(0)	7
	RY13	18	(100)	0	(0)	18
	RY14	15	(100)	0	(0)	15
6A West	RY10	12	(100)	0	(0)	12
	RY11	13	(100)	0	(0)	13
	RY12	12	(100)	0	(0)	12
	RY13	11	(100)	0	(0)	11
	RY14	15	(100)	0	(0)	15
6B	RY10	25	(100)	0	(0)	25
	RY11	16	(100)	0	(0)	16
	RY12	17	(100)	0	(0)	17
	RY13	22	(100)	0	(0)	22
	RY14	20	(100)	0	(0)	20
6C	RY10	18	(58)	13	(42)	31
	RY11	17	(63)	10	(37)	27
	RY12	22	(39)	34	(61)	56
	RY13	29	(38)	47	(62)	76
	RY14	45	(57)	34	(43)	79
6D	RY10	4	(100)	0	(0)	4
	RY11	6	(100)	0	(0)	6
	RY12	4	(100)	0	(0)	4
	RY13	3	(100)	0	(0)	3
	RY14	3	(100)	0	(0)	3
Unit 6	RY10	77	(86)	13	(14)	90
	RY11	71	(87)	10	(13)	81
	RY12	62	(65)	34	(35)	96
	RY13	83	(64)	47	(36)	130
	RY14	98	(74)	34	(26)	132

[a] A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Total is for reported harvest only; unreported, illegal, or accidental kill combined total probably less than 5 animals in each area each year.

Table 6. Unit 6, Alaska moose harvest data by permit hunt, regulatory years[a] 2010–2014.

Unit/ Hunt number [b]	Year	Legal moose	Permits Issued	Percent did not hunt	Percent successful hunters	Bulls	(%)	Cows	(%)	Total reported harvest
6A/RM160	RY10	Bull	70	61	41	11	(100)	0	(0)	11
	RY11	Bull	53	60	57	12	(100)	0	(0)	12
	RY12	Bull	46	67	53	8	(100)	0	(0)	8
	RY13	Bull	50	60	40	8	(100)	0	(0)	8
	RY14	Bull	43	53	65	13	(100)	0	(0)	13
6A/DM160	RY10	Bull	5	40	33	1	(100)	0	(0)	1
	RY11	Bull	5	60	50	1	(100)	0	(0)	1
	RY12	Bull	5	20	100	4	(100)	0	(0)	4
	RY13	Bull	5	20	75	3	(100)	0	(0)	3
	RY14	Bull	5	40	67	2	(100)	0	(0)	2
6B/RM164	RY10	Bull	233	37	17	25	(100)	0	(0)	25
	RY11	Bull	197	36	13	16	(100)	0	(0)	16
	RY12	Bull	177	41	16	17	(100)	0	(0)	17
	RY13	Bull	163	42	23	22	(100)	0	(0)	22
	RY14	Bull	151	40	22	20	(100)	0	(0)	20
6C/DM167	RY10	Bull	6	17	80	4	(100)	0	(0)	4
	RY11	Bull	13	31	67	6	(100)	0	(0)	6
	RY12	Bull	7	0	86	6	(100)	0	(0)	6
	RY13	Bull	7	0	100	7	(100)	0	(0)	7
	RY14	Bull	12	17	100	10	(100)	0	(0)	10
6C/	RY10	Both	33	3	84	14	(52)	13	(48)	27

Federal Subsistence[c]	RY11	Both	24	4	91	11	(52)	10	(48)	21
	RY12	Both	58	3	89	16	(32)	34	(68)	50
	RY13	Both	73	4	99	22	(32)	47	(68)	69
	RY14	Both	72	1	97	35	(51)	34	(49)	69

[a] A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] RM prefix was a registration hunt, DM prefix a drawing hunt.
[c] Federal subsistence hunts, including bull, antlerless, and potlatch bull.

Table 7. Unit 6, Alaska moose hunter residency and success, regulatory years[a] 2010–2014.

		Successful					Unsuccessful					
Unit	Year	Local[b] resident	Nonlocal resident	Non-resident	Total	(%)	Local resident	Nonlocal Resident	Non-resident	Total	(%)	Total hunters
6A East	RY10	0	0	18	18	(60)	1	0	11	12	(40)	30
	RY11	1	0	17	19[c]	(56)	0	2	13	15	(44)	34
	RY12	0	1	6	7	(41)	0	4	6	10	(59)	17
	RY13	0	4	14	18	(47)	2	2	16	20	(53)	38
	RY14	0	2	13	15	(60)	0	1	9	10	(40)	25
6A West	RY10	10	1	1	12	(40)	12	4	2	18	(60)	30
	RY11	11	1	1	13	(57)	7	2	1	10	(43)	23
	RY12	7	1	4	12	(63)	7	0	0	7	(37)	19
	RY13	7	1	3	11	(46)	8	4	1	13	(54)	24
	RY14	10	3	2	15	(65)	4	3	1	8	(35)	23
6A TOTAL	RY10	10	1	19	30	(50)	13	4	13	30	(50)	60
	RY11	12	1	18	32[c]	(56)	7	4	14	25	(44)	57
	RY12	7	2	10	19	(53)	7	4	6	17	(47)	36
	RY13	7	5	17	29	(47)	10	6	17	33	(53)	62
	RY14	10	5	15	30	(63)	4	4	10	18	(38)	48
6B	RY10	19	6	0	25	(17)	108	14	0	122	(83)	147
	RY11	15	1	0	16	(13)	93	17	0	110	(87)	126
	RY12	16	1	0	17	(16)	81	6	0	87	(84)	104
	RY13	19	3	0	22	(23)	65	8	0	73	(77)	95
	RY14	18	2	0	20	(22)	63	8	0	71	(78)	91

Table 7, continued.

		Successful					Unsuccessful					
Unit	Regulatory year	Local[b] resident	Nonlocal resident	Non-resident	Total	(%)	Local resident	Nonlocal resident	Non-resident	Total	(%)	Total hunters
6C	RY10	30	1	-	31	(84)	6	0	-	6	(16)	37
	RY11	22	5	-	27	(84)	2	3	-	5	(16)	32
	RY12	53	4	-	57	(90)	6	0	-	6	(10)	63
	RY13	76	0	-	76	(99)	1	0	-	1	(1)	77
	RY14	73	6	-	79	(98)	2	0	-	2	(2)	81
6D	RY10	3	1	0	4	(13)	24	3	1	28	(88)	32
	RY11	5	1	0	6	(19)	18	6	1	25	(81)	31
	RY12	3	1	0	4	(13)	21	3	3	27	(87)	31
	RY13	3	0	0	3	(8)	27	6	1	34	(92)	37
	RY14	3	0	0	3	(14)	13	4	1	18	(86)	21
Unit 6 TOTAL	RY10	62	9	19	90	(33)	151	21	14	186	(67)	276
	RY11	54	8	18	81[c]	(33)	120	30	15	165	(67)	246
	RY12	79	8	10	97	(41)	115	13	9	137	(59)	234
	RY13	105	8	17	130	(48)	103	20	18	141	(52)	271
	RY14	104	13	15	132	(55)	82	16	11	109	(45)	241

[a] regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Residents of Unit 6.
[c] Includes 1 hunter with unknown residency.

Harvest Chronology

Harvest is protracted in Unit 6A and Unit 6C, occurring between September and mid-October. In Unit 6B, most harvest is concentrated in early September. In Unit 6D, moose are only taken in September due to the season dates (1–20 September). During this reporting period over 40% of the harvest in Unit 6 occurred in the first 15 days of September (Table 8).

Transport Methods

Unit 6A is the only area where a significant proportion of the harvest is airplane supported (Table 9). Airboats, boats, and ORVs (including 3- and 4-wheelers) are also utilized, particularly in the Bering River portion (Unit 6A West). Local hunters use larger boats (seiners or tenders) to transport smaller vessels for use in the hunt. Harvest in Unit 6B predominantly utilizes airboats although in this reporting cycle highway vehicles were more popular than in previous years. Unit 6C has good road access from Cordova, allowing both highway vehicle and airboat access to moose. Unit 6D harvest occurs by boat and highway vehicle or 3- or 4-wheeler; however, with such a small number of participants these data are only summarizing the tendencies of a few individual hunters. This pattern of use has not changed over the past 5 years.

Other Mortality

Brown bears and black bears undoubtedly prey upon moose calves and, to a lesser degree, adult moose. However, the magnitude of these events is poorly understood. As in previous periods, brown bears and wolves were observed chasing and feeding on calves and adult moose throughout the moose range of Unit 6 (Dave Crowley, former Cordova ADF&G Area Management Biologist, personal communication). Estimates Carnes (2004) made of moose kill rates for wolves in Unit 6 were low compared to other areas of Alaska. However, calf survival, measured by the percent calves seen on spring surveys, is lowest in Unit 6A where predator populations are likely highest. The percent of calves observed may indicate that young cohorts are not recruiting into the adult population in adequate numbers. Calf survival is highest in Unit 6C where predator populations are more regulated by hunting pressure (Table 1).

Moose are known to be more susceptible to predation during deep snow winters. Unit 6 can experience deep snow events with variable persistence. The winter of RY11 was a 100-year weather event with 10 feet of snowfall in 2 weeks, which was persistent well into the spring. Despite this weather event, calf recruitment in Unit 6B and Unit 6C in RY11 surveys fell within normal ranges. The nature of the snow pack may have influenced the effect on the moose population. The snow contained numerous hard layers that prevented moose from “punching through” and being limited by its full depth.

Table 8. Unit 6, Alaska moose harvest percent by time period, regulatory years[a] 2010–2014.

		Harvest periods (%)							
		Aug	Sep		Oct		Nov	Dec	
Unit	Year	20–31	1–15	16–30	1–15	16–31	1–30	1–31	*n*
6A	RY10	0	30	20	17	33	0	0	30
	RY11	0	47	28	25	0	0	0	32
	RY12	0	47	26	26	0	0	0	19
	RY13	0	31	31	10	28	0	0	29
	RY14	0	37	30	23	10	0	0	30
6B	RY10	0	48	44	8	0	0	0	25
	RY11	0	56	31	6	6	0	0	16
	RY12	0	47	6	47	0	0	0	17
	RY13	0	50	23	14	14	0	0	22
	RY14	0	90	10	0	0	0	0	20
6C[b]	RY10	0	32	39	6	13	3	6	31
	RY11	0	50	8	31	4	4	4	26
	RY12	0	52	16	13	5	7	7	56
	RY13	0	47	30	8	8	3	4	74
	RY14	0	46	18	20	10	4	3	79
6D	RY10	0	50	50	0	0	0	0	4
	RY11	0	17	83	0	0	0	0	6
	RY12	0	25	75	0	0	0	0	4
	RY13	0	0	100	0	0	0	0	3
	RY14	0	67	33	0	0	0	0	3
Unit 6 TOTAL	RY10	0	37	34	10	16	1	2	90
	RY11	0	48	26	21	3	1	1	80
	RY12	0	49	19	21	3	4	4	96
	RY13	0	43	30	9	13	2	2	128
	RY14	0	51	20	17	8	2	2	132

[a] A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Number of moose harvested (n) in 6C may not include all federal subsistence harvest because date of kill is not consistently reported.

Table 9. Unit 6, Alaska moose harvest percent by transport method, regulatory years[a] 2010–2014.

Unit	Regulatory year	Airplane	Boat	Airboat	3- or 4-wheel ORV	Highway Vehicle	*n*
6A	RY10	40	20	17	23	0	30
	RY11	42	10	29	19	0	32
	RY12	61	11	28	0	0	19
	RY13	61	21	14	0	4	29
	RY14	53	20	27	0	0	30
6B	RY10	22	22	48	0	9	23
	RY11	13	0	80	0	7	15
	RY12	0	21	57	14	7	14
	RY13	0	5	55	0	40	20
	RY14	18	6	24	0	53	17
6C[b]	RY10	0	3	45	19	32	31
	RY11	0	4	50	13	33	24
	RY12	0	2	30	11	57	56
	RY13	0	0	47	10	43	72
	RY14	1	5	44	10	40	78
6D	RY10	0	75	0	25	0	4
	RY11	17	33	0	17	33	6
	RY12	0	25	0	0	75	4
	RY13	0	67	0	33	0	3
	RY14	0	67	0	33	0	3
Unit 6 TOTAL	RY10	19	17	34	16	14	88
	RY11	21	8	43	13	14	76
	RY12	12	8	33	9	39	92
	RY13	14	7	40	7	33	123
	RY14	16	10	36	7	31	128

[a] A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Number of moose harvested (*n*) in 6C does not include all federal subsistence harvest because hunter transportation is not always recorded.

Alaska Board of Game Actions and Emergency Orders

The resident MAH for the portion of Unit 6A West was up to 20 bulls by registration permit, and nonresident MAH was up to 5 bulls by drawing permit. The MAH has not been met for this area since RY05.

The season in Unit 6B was 1 September–30 November (unless the MAH is met) for resident hunters only with a bag limit of 1 moose. The MAH of 25 bulls by registration permit had not been met since RY10. The MAH was lowered to 20 bulls in RY14 to reduce the harvest rate on a population that has been below objectives. In RY14, the MAH was met and an emergency order was issued on September 20. In RY15, the MAH was met and an emergency order was issued on September 10.

The Board of Game reauthorized antlerless moose hunts in Unit 6C each year during the reporting period. An agenda change request was also used to modify the provisions of the Unit 6B Moose Controlled Use Area to allow the use of a motorized vehicle to cross the portion of the Copper River where the bridge has washed out and then resume motorized vehicle usage only on the Copper River Highway.

Recommendations for Activity 2.1.

Continue to monitor harvest data and mortality data as possible.

3. Habitat Assessment–Enhancement

ACTIVITY 3.1. Conduct twinning surveys in one subunit annually.

Data Needs

Twinning surveys were flown in RY14 and RY15 in Unit 6B for the first time to acquire a baseline assessment of twining rate. The Unit 6C twinning survey in RY15 sought to continue to assess habitat status as the population has exceeded its population objective.

Methods

We conducted moose twinning surveys using a Piper Super Cub PA-18 airplane flown at low level (200–600 feet above ground level), searching brush lines bordering large meadows and stream braids. Each day, a unique portion of the area was surveyed. The objective of each survey was to see as many parturient cows as possible. Each moose observed was classified based on sex and parturition status, e.g., bull, yearling, and cow w/ 0, 1, or 2 calves. Moose observations, weather, visibility and relative moose activity were recorded on data forms. Survey tracks and locations of moose were marked and mapped using a GPS unit.

Twinning rates are calculated based on peak twinning which takes multiple flights to determine and were also calculated cumulatively. However, multiple surveys are not possible when leaf-out is advanced, budgets are tight, or weather is bad. Surveys were flown in the morning (starting prior to 9 a.m.) with calm winds and limited precipitation, which were the most likely conditions for cows with calves to be active and visible. Our sample goal was 30 parturient cows in one survey, however, data can also be considered cumulatively since it is proportional. Twinning rates were calculated as: 100* (cows with 2 calves/all cows with calves).

Results and Discussion

Individual survey reports provide more detail and can be found in Appendix E. Twinning surveys were unsuccessful in RY13 due to early leaf emergence. In RY14 in Unit 6B, only 6 parturient cows were observed, 4 with twins and 2 with a single calf (Table 10). Although this sample size is inadequate to be considered representative it constitutes a 66% twinning rate. A total of 68 moose were observed, which was 30% of the most recent population estimate (227, February 2014; Table 1).

Table 10. Unit 6B, Alaska twinning survey results, regulatory year[a] 2014.

	Cows			Total	%	Hours	Twinning
Date	0 calf[b]	1 calf	2 calf	Moose[c]	Calves	searched	rate
25–26 May 2015	31	2	4	68	15	7	66.7

[a] A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Cows with 0 calf likely includes yearling bulls and cows that are likely to be misclassified.
[c] Total moose includes yearlings and bulls.

The survey on the west delta (Unit 6C) yielded a similar number of parturient cows relative to peak counts in other years with 21 parturient cows observed (Table 11).

Table 11. Unit 6C, Alaska twinning survey results, regulatory years[a] 2007–2014.

	Cows			Total	%	Hours	Twinning
Date	0 calf[b]	1 calf	2 calf	Moose[c]	calves	searched	rate
27 May 2015	55	5	16	134	28	7	76.2
21 May 2013	61	5	5	93	16	4	50.0
23 May 2013	102	5	6	146	12	7	54.5
29 May 2013	57	11	10	108	29	7	47.6
23 May 2012	46	7	5	78	22	6.4	41.7
28 May 2012	66	13	12	142	26	3.75	48.0
26 May 2009	21	2	4	45	22	2.5	66.7
28 May 2009	40	8	7	82	27	2.7	46.7
29 May 2008	46	8	11	103	29	3.75	57.9
07 June 2008	13	3	3	41	22	3	50.0
26 May 2007	41	4	8	91	22	3.5	66.7
12 June 2007	50	3	5	84	15	3.3	62.5

[a] A regulatory year (RY) begins 1 July and ends 30 June, e.g., regulatory year 2010 = 1 July 2010–30 June 2011.
[b] Cows with 0 calf likely includes yearling bulls and cows that are likely to be misclassified.
[c] Total moose includes yearlings and bulls.

Of these cows, 16 had twins and 5 had single calves. The survey found 134 moose (22% of the 609 February 2014 estimate), also comparable with other peak counts of moose. Although this sample size is also less than ideal to be considered representative, a 76% twinning rate was observed.

Recommendations for Activity 3.1

Continue. Twinning rates are an important index to track as the population grows beyond its original objectives.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Federal records have not been updated in the WinfoNet system since 2010. Records in WinfoNet for 2001–2010 contain errors and omissions.

Data Recording and Archiving

- GSPE data are stored on an internal database housed on a server (http://winfonet.alaska.gov/index.cfm).
- Data sheets are scanned and stored on the Cordova ADF&G server (O:\DWC\Moose)
- Original datasheets are stored in file folders located in the Cordova Area Biologist's office.
- Historical survey notes and data sheets are being digitized and scanned for permanent storage on the file server.

Agreements

Alaska Department of Fish and Game and USFS Chugach National Forest have a cooperative agreement that allows for financial support and the sharing of harvest data.

Permitting

None.

Conclusions and Management Recommendations

Moose populations in Units 6A and 6B have been below management objectives for many years. These objectives were set in the absence of habitat data. These populations may be stabilized at low densities and may be influenced by high predation compared to moose in Unit 6C where wolves and bears are more aggressively pursued by hunters. The moose population in Unit 6C appears to be high and possibly growing. Cow hunts will continue to be used to allow for harvest and prevent accelerated growth of the population.

Additional twinning surveys should be conducted in Unit 6B to evaluate habitat. If twinning rates are as high in Unit 6B as in Unit 6C, a compelling case could be made that predation is inhibiting the growth of this population. However, if the habitat is not as productive in Unit 6B as it is in Unit 6C, it may be indicative that the population objectives that have been set are not appropriate. Only 4 times in the entire history of monitoring moose in this area has the population estimate fallen within its objective (1991, 1992, 1996, and 1998). Twinning surveys should also continue in Unit 6C as the population continues to grow and has exceeded population objectives despite aggressive harvest rates (including on cows). Rump fat depth and/or short yearling weights may also be used to evaluate resource constraints. A revised carrying capacity estimate was generated for Unit 6C (the west CRD) and will be consulted when modifying existing management objectives in a public process (Smythe 2015).

Fall composition surveys should continue to rotate between survey areas to monitor for the potential effects of selective harvest pressure. Unit 6B fall composition should be examined with the highest priority. It is likely that the inability of this population to increase into the range of the management objective is related to lower recruitment but fall composition surveys and habitat data will help clarify what is driving this population.

II. Project Review and RY15–RY19 Plan

Review of Management Direction

MANAGEMENT DIRECTION

A public process is underway to review the results of the carrying capacity study and to revise management objectives based on new information about the population and habitat.

GOALS

Our goals in Unit 6A East are to take large moose and to provide for optimum harvest. For the remainder of Unit 6, the goals are to provide for optimum harvest and to provide for the greatest opportunity to hunt.

CODIFIED OBJECTIVES

Amount Reasonably Necessary for Subsistence Uses

Moose in Unit 6 have a negative customary and traditional use finding.

Intensive Management

Moose in Unit 6 have a negative intensive management finding.

MANAGEMENT OBJECTIVES

Our management objective for Unit 6A East is to maintain a population of 300–350 moose and a minimum bull:cow ratio of 30:100. Our objectives for Units 6A West and 6B are to maintain populations of 300–350 moose and minimum bull:cow ratios of 15:100 in each unit.

The Prince William Sound/Copper River Delta Fish and Game Advisory Committee reviewed current information regarding the moose population and habitat in Unit 6C. The committee voted unanimously to revise management objectives for this area to the following: In Unit 6C, our objective is to maintain a population of 600–800 moose and a minimum bull:cow ratio of 25:100 to maintain a healthy distribution among age classes of bulls.

REVIEW OF MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Estimate late winter abundance in at least one survey area annually.

and

ACTIVITY 1.2. Estimate calf recruitment in at least one late winter survey area annually.

Data Needs

No change from report.

Methods

Future surveys will apply similar methods to those described in the report and Appendices A and B. Snow during the last two winters has been inadequate for survey completion. The next time adequate survey conditions exist, all areas must be surveyed. In the past, only one or two subunits have been selected for completion. We will complete a GSPE survey using biometric support to prioritize sample size among strata and appropriate use of SCF units.

ACTIVITY 1.3. Estimate fall composition in at least one area annually.

Data Needs

No change from RY10–RY14.

Methods

Continue with random sampling to lessen sampling bias. Record prevalence of dropped antlers.

2. Mortality-Harvest Monitoring

ACTIVITY 2.1. Monitor mortality and harvest in Unit 6 annually.

Data Needs

No change from RY10–RY14.

Methods

We will continue to follow methods from the prior reporting period.

3. Habitat Assessment-Enhancement

ACTIVITY 3.1. Conduct twinning surveys in one subunit annually.

Data Needs

No change from RY10–RY14.

Methods

Twinning surveys will continue to be conducted with caution but as a general indicator of habitat condition. We will continue to strive for higher sample size, especially in years where timing of parturition coincides with ideal sightability (prior to leaf out.)

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Federal/State data sharing issues must be resolved at higher levels than the ADF&G/DWC area office. Federal records have not been updated in the WinfoNet system since 2010. Records that exist in the system contain errors and omissions. Currently, we have access to these records (more than ¾ of the harvest in Unit 6C, the subunit with the highest harvest) using the informal sharing of a Microsoft Excel spreadsheet between the USFS subsistence biologist and ADF&G. These data should be stored in a way that protects records from erroneous modification, while documenting changes, and is password protected. Additionally, the current form of data sharing depends on positive relationships among parties and is not a viable long-term solution. Entering these data into a secure database would ensure that all parties can access secure information and that hunt records are collected consistently and accurately.

Data Recording and Archiving

- GSPE data will be stored on an internal database housed on a server (http://winfonet.alaska.gov/index.cfm).
- Data sheets will be scanned and stored on the Cordova ADFG server (O:\DWC\Moose)
- Original datasheets will be stored in file folders located in the Cordova Area Biologist's office.
- Historical survey notes and data sheets are being digitized and scanned for permanent storage on the file server.

Agreements

Alaska Department of Fish and Game and USFS Chugach National Forest have a cooperative agreement signed in 2014 that allows for financial support and the sharing of harvest data.

Permitting

None.

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Appendix A. Regulatory year 2013 moose population estimate, Units 6B and 6C, Alaska.

THE STATE of ALASKA
GOVERNOR SEAN PARNELL

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DIVISION OF WILDLIFE CONSERVATION
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March 25, 2014

MEMORANDUM

To: Gino Del Frate
Management Coordinator
Anchorage

From: Charlotte Westing
Wildlife Biologist III
Wildlife Conservation Division
Cordova

Subject: Completion of moose population estimate surveys in GMU 6C, west Copper River Delta and GMU 6B east of the Copper River, including the Martin River drainages.

INTRODUCTION

Moose populations in most of Unit 6 originated from translocations of calves from the Kenai Peninsula, Anchorage, and the Matanuska-Susitna area (Paul 2009). Hunting in Unit 6C (West Copper River Delta) began with 25 bulls harvested in 1960. Since that time, about 70 moose (26% cows) are taken annually from the subunit. Harvest began in Unit 6B (east of the Copper River, including the Martin River) during 1965. Since 2010, the quota has been 25 bulls. In years prior it was as low as 10 bulls (RY2000). The average harvest for the last 25 years is 27 moose. Cow hunts have not been held in Unit 6B since 1996 (Crowley, 2010).

Population estimate surveys are conducted as soon as snow conditions and weather allows, usually in February. Conducting surveys at this time allows for maximum sightability although most bulls have shed their antlers so animals are classified as either adults or calves. Calves: 100 adults is a good estimate of recruitment and can be used to understand winter mortality. From 1964 to 1990, the population was monitored using minimum count techniques. However, minimum count data does not contain measures of precision and is unreliable for population trend monitoring. From 1992-2012, the population has been monitored using Gasaway surveys (Gasaway et al., 1987). This technique involves a stratified random sample of areas with varying levels (high, medium, or low) of moose density. Stratification is generally used to increase efficiency by focusing more efforts in areas where moose occur and to increase estimate precision. Additionally, intensive surveys were done to assess sightability. Data from these surveys are used to understand population trajectories, determine quotas, and set management priorities.

METHODS

This winter has been remarkable for minimal snow fall and retention. However, numerous snow showers over a week period resulted in more than 12 inches of snow in our study area and ideal survey conditions. On February 19, we began with a stratification flight in a C-185 piloted by Mike Collins, and completed all but a small portion of 6B (13 of 75 sample units) which was "desktop stratified". The following two days, our efforts were limited by lingering snow showers. We began surveys in 6B February 20 in two Piper Super Cub aircraft (PA-18), piloted by Mike Collins, and Jared Kennedy. Charlotte Westing (ADFG), Samantha Stevenson-Renner (ADFG), Ray Renner (volunteer), and Milo Burcham (volunteer) served as observers. Stratification was completed in 6C on February 21 and sampling with a super cub in 6C began that afternoon. Sample units were flown in both 6B and 6C on February 22, and 24. All flights were between 300 and 800 feet above ground level. Search intensity was between 4-6 minutes per square mile of habitat.

Survey techniques this year used a random sample of units (approximately 6.5 square miles) within the Geospatial Population Estimate (GSPE) survey protocol (Kellie and DeLong, 2006). Initial selection was for 30 units in 6B with a 60/40 split between highs and lows. The initial selection for 6C was for 20 units with an 85/15 split between highs and lows based on the reduced prevalence of lows in 6C. A minimum of 20 units is required for each stratum to use the GSPE. Waypoints were taken for groups of animals to record distribution, gauge sightability, and determine inclusion in GSPE analysis. Observations of other wildlife were opportunistically recorded such as coyotes or wolves.

Sightability was assessed by resampling half of a selected unit again with an intensity of 9-12 minute per square mile of habitat. To do this without bias, envelopes were loaded with slips of paper indicating whether or not a unit was selected for sightability and if so, which half should be done. The goal for generating a Sightability Correction Factor (SCF) was 15 units in each stratum. Using daily track logs from survey flights and data sheet comments, moose were identified as found in the standard survey or in addition to those found in the standard survey.

Earl Becker (ADF&G) gave biometric support to this project by generating an optimum sample allocation algorithm (using R statistical software) to better isolate significant sources of variance and to optimize personnel time (and ultimately budget). Each evening, survey data were analyzed. Results were used to determine how additional samples should be allocated between strata and how many additional SCF units should be flown.

Data from the high strata were analyzed using the GSPE analysis tool in Winfonet. GSPE uses spatial autocorrelation which can reduce variance. Without the requisite 20 lows sampled, the web interface for GSPE analysis could not generate an estimate even if only for the high strata. Therefore, 5 lows were designated as sampled with zero moose to allow for the analysis. Because this estimate only considered high strata, these data do not affect the estimate.

Data that was collected in selected sample units in the low strata were analyzed using the Gasaway technique using R statistical software code. Additionally, Gasaway analysis was performed for all strata to compare against the GSPE to assess accuracy and precision between the two techniques. This was an informative exercise as we transition from one technique to another.

RESULTS AND DISCUSSION

Surveys were performed between February 19 and February 24. In total, 39.4 hours were flown between the two survey planes. Search time varied as influenced by habitat and the presence of moose. Average search intensity per sample unit (approximately 6.5 square miles) was 23 minutes. Of the 124 sample units in the study area, 58 were sampled (47%) with a 74/26 distribution of highs to lows (Figure 1).

By survey completion, 397 moose were observed (Table 1). GMU 6C (west of the Copper River) held the majority (73%) of these animals. Calf success may also be higher in Unit 6C with 20% of the moose observed being calves compared with 15% calves in GMU 6B (east of the Copper River including Martin River drainages.)

To test the appropriateness of using the GSPE to analyze data from the high strata rather than previously used Gasaway, estimates of observable moose were generated using each technique. Estimates were virtually identical with 837 moose for the entire area using the GSPE, and 831 moose for the entire area using the Gasaway technique (Table 2). However, the precision of the estimate improved (GSPE Standard Error (SE) of 82.03 compared with Gasaway SE 100.4.) For management purposes, separate population estimates for sub areas 6B and 6C were required. To obtain GSPE subestimates, we fit a spatial model to all the data and pulled out separate estimates for each sub area. We would generally expect the GSPE estimates to be as precise or more precise than the Gasaway estimates, while this was true for subunit 6C, it was not true for sub unit 6B (SE: GSPE = 57.98, Gasaway = 35.46, Table 2 using the 6B Dependent results). There is an assumption in the GSPE that there is constant variance throughout the spatial extent of a survey area. Comparing the observed number of moose counted per sample unit between the two areas suggests a possible violation of this assumption (Figure 2). To test this, we split the data up by the two areas and ran the high strata through the GSPE independently. This analysis produced more typical SE results (labeled Independent in Table 2) in which the GSPE estimator was more precise than the Gaswaway estimator for both areas (SE 6B: 29.56 vs 35.46; SE 6C: 72.80 vs 84.39). Estimates using independent data are more appropriate and were used in final population estimate generation.

Search intensity for the SCF samples averaged 17.6 minutes for a sample area of about 3.25 square miles. Standard surveys in sample units that were selected for SCF generation found 93 moose. When these units were resampled more intensively for SCF, 102 moose were observed. This resulted in an SCF for the survey of 1.16 for the high strata (SE= 0.037). The low strata contained no observable moose when sampled on standard surveys and SCF surveys. Therefore, the SCF for low strata is 1.0 (SE= 0). We did not have the resources to collect enough data to analyze 6B and 6C SCF data separately. The SCF may be more appropriate for 6C because the majority of the moose were observed there. In 6B, where moose are in much smaller groups, it may be easier to sort out tracks and make certain that all moose are observed. However, in 6C where many moose are observed in a sample unit, it can become increasingly difficult to keep things straight. GPS screens become very cluttered and it may be difficult to ensure good coverage. I suspect that this may bias the 6B point estimate a bit high.

Estimates of moose were generated for each subunit based on observable moose and the SCF. The point estimate for 6C, west of the Copper River Delta is 609 (90% CI 483-734) (Table 1.) This is virtually identical to the previous estimate in 2012 of 601 and is above management objectives (400-500 moose) (Figure 3.) We will continue to conduct twinning surveys when possible and may weigh short yearlings in the future to look for indications of habitat stress. A revised carrying capacity estimate (from Sharon

Smythe, Oregon State University) is expected this spring and may provide further insight into adjusting management objectives.

The point estimate for 6B, east of the Copper River Delta and including the Martin River Valley, is 227 (90% CI 177-278) (Table 1.) All of the results for the last five surveys fall within the confidence intervals for this survey. This population has been below the management objective of 300-350 for 15 years (Figure 4). Twinning surveys should be conducted to evaluate habitat and could give a qualitative look at predation. Future adjustments may be made to the quota for the hunt in 6B (locally referred to as the Martin River hunt.) Fall composition surveys should be conducted to gauge any potential effects of selective harvest. It is likely that the inability of this population to increase into the range of the management objective is related to lower recruitment. However, the management objective for this area may simply be unreasonable based on what the area can support. In fact, only four times in the entire history of monitoring moose in this area has the population estimate fallen within its objective (1991, 1992, 1996, and 1998.)

Special thanks to goes to our phenomenal local pilots, Mike Collins and Jared Kennedy. The survey would not have been possible without the volunteer efforts of Milo Burcham, and Ray Renner. Samantha Stevenson-Renner provided tremendous support to make the survey run smoothly. The US Forest Service, Cordova Ranger District contributed to funding this study. Biometric and planning support from Earl Becker added significant rigor and is greatly appreciated.

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Table 1: Result from 2014 (RY2013) population estimates in GMU 6C (west of the Copper River) and GMU 6B (east of the Copper River including the Martin Valley).

Area	Population Estimate	90% CI	Adult Estimate	Calf Estimate	Calves: 100 Adults	% Surveyed	Moose Observed
6C	609	483-734	487	124	25	51	291
6B	227	177-278	196	33	17	45	106
Total[a]	837	697-977	685	155	23	47	397

[a] Estimates are not the sum of 6C and 6B

Table 2: Comparison of Gasaway and GSPE 2014 population estimates for moose in GMU 6B and 6C.

	Gasaway[a]		GSPE	
	Estimate	Standard Error	Estimate	Standard Error
6B/6C Combined	831	100.40	837	82.03
6B Dependent			249	57.98
6B Independent	225	35.46	227	29.56
6C Dependent			589	51.98
6C Independent	610	84.39	609	72.80

[a] Gasaway analyses are all independent, whereas GSPE can calculate estimates of subareas (refered to as dependent) while retaining information for the whole area. Independent analyses in GSPE only contain the area of interest.

Figure 1:

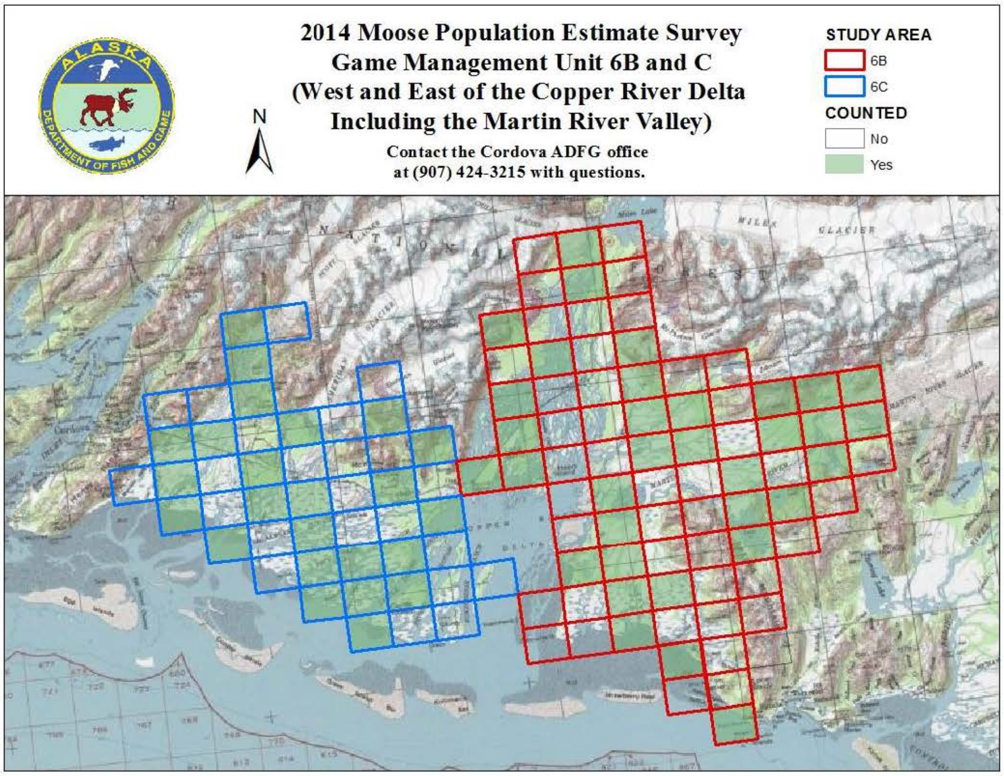

2014 Moose Population Estimate Survey
Game Management Unit 6B and C
(West and East of the Copper River Delta
Including the Martin River Valley)
Contact the Cordova ADFG office
at (907) 424-3215 with questions.
N
STUDY AREA
6B
6C
COUNTED
No
Yes

Figure 2:

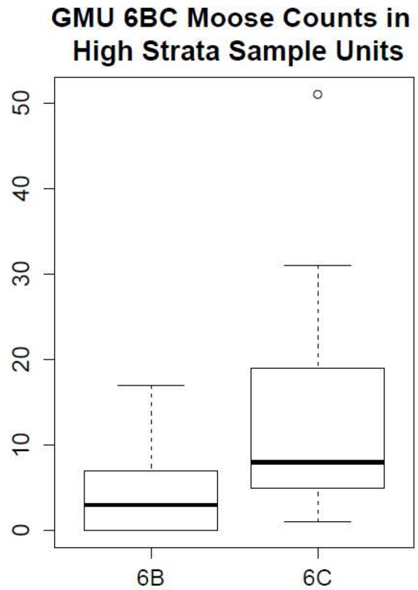


Figure 3:

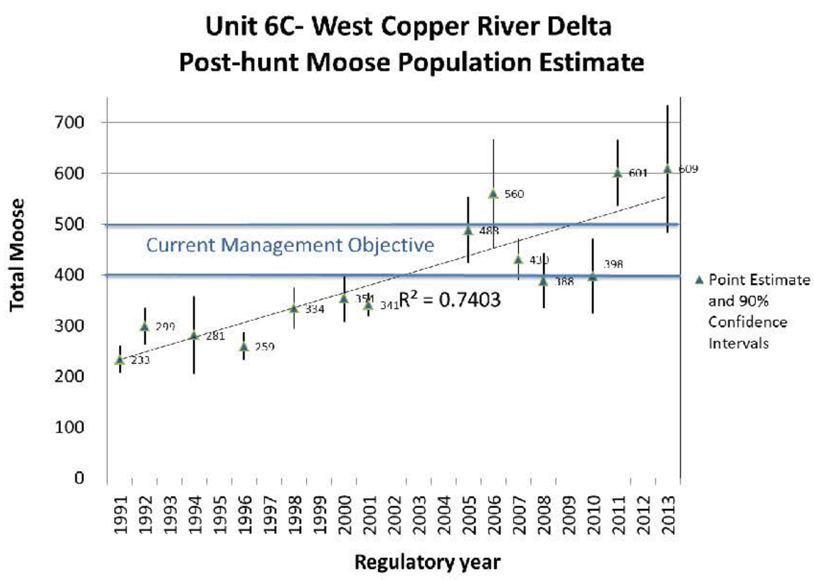
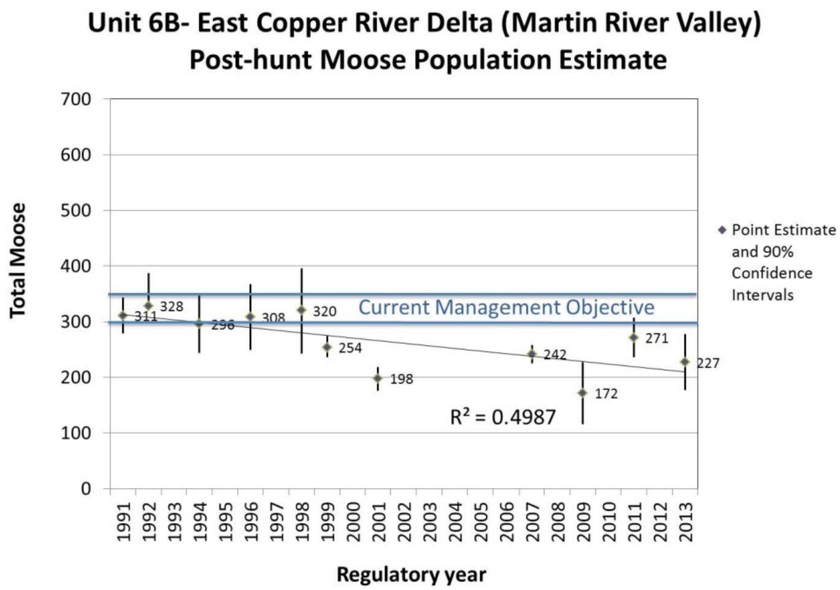


Figure4:


Unit 6B- East Copper River Delta (Martin River Valley)
Post-hunt Moose Population Estimate
Total Moose
700
600
500
400
300
200
100
0
311
328
296
308
320
254
198
242
172
271
227
Current Management Objective
R² = 0.4987
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Regulatory year
Point Estimate and 90% Confidence Intervals

Appendix B. Regulatory year 2014 moose recruitment estimate, Unit 6A, Alaska.

THE STATE of ALASKA
GOVERNOR BILL WALKER

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April 17, 2015

MEMORANDUM

To: Gino Del Frate
Management Coordinator
Anchorage

From: Charlotte Westing
Wildlife Biologist III
Wildlife Conservation Division
Cordova

Subject: Completion of moose recruitment surveys in GMU 6A West, Palm Point to Cape Suckling

INTRODUCTION

Moose populations in most of Unit 6 originated from translocations of calves from the Kenai Peninsula, Anchorage, and the Matanuska-Susitna area conducted from 1948- 1958(Paul 2009). By the late 1960s, moose had expanded to the Bering River area of Unit 6A West. Hunting in Unit 6A (drainages east of Palm Point) began in 1971. The population objective for Unit 6A West is 300-350 moose. This objective was met starting in RY88 but not since the survey in RY01. Additionally, calf recruitment was very low in the last surveys that were conducted in RY07 (7calves: 100 adults) and RY08 (4 calves: 100 adults).

Moose surveys have been conducted in this area since 1969. Minimum count data was collected from RY69 to RY87. Starting in RY92 spring estimates were generated using the Gasaway technique on a 1-4 year interval (Crowley 2010). A spring population estimate or recruitment survey has not been performed in this area since RY08 due to budgets and other competing moose survey priorities. This year was scheduled to receive a survey but the requisite snow threshold was not met. Therefore, a recruitment survey was conducted to document the abundance of calves in a winter with minimal snow and to use as a baseline. This metric may be useful to understand the potential impacts of predation and to understand winter mortality. Aggressive wolf trapping has begun in this area. If a population estimate can be conducted next year, the comparison may be very informative.

METHODS

This winter has been remarkable for minimal snow fall and retention. Until March 9th, no precipitation had fallen or accumulated in the form of snow. While it was clear based on weather cameras that some snow had appeared, the depth and distribution was unknown. High winds prevented reconnaissance for two days. By March 11, we received a pilot report (Sam Fejes, personal communication) that detailed snow coverage in the area. The amount of snow was insufficient for a population estimate so the focus of the survey changed to recruitment assessment. On March 11, we began surveys in 6A West in two Piper Super Cub aircraft (PA-18), piloted by Mike Collins, and Jared Kennedy. Charlotte Westing and Milo Burcham (volunteer) served as observers. Sample design was unrestricted with the objective to observe the maximum number of moose since recruitment data is proportional.

The area was divided between the two planes using the Campbell River to maintain spatial separation. Pilots flew at 300 and 800 feet above ground level. When moose were observed they were circled to confirm that other animals were not associated with them. In the area north of the Campbell River, snow cover was complete throughout most of the area. South of the Campbell River, snow cover diminished gradually from northwest to southeast varying from 4 to zero inches of snow. Light conditions were ideal. Observations of other wildlife were also recorded such as coyotes, goats, and bears.

RESULTS AND DISCUSSION

The survey was performed on March 11 (9.4 hours). Search time varied as influenced by habitat and the presence of moose. Considering the entire survey area (554 square miles), search intensity was 1 min/sq. mile. However portions of the area were not surveyed due to the perceived low probability of moose. After removing these areas from the calculations, intensity was 1.6 min/square mile.

By survey completion, 160 moose were observed, 65% of the last population estimate (RY08) of 245 moose (Table 1). However, with 6 years between data points, it is impossible to know what proportion of the population has truly observed. Twenty of these moose were calves and 140 were adults. One moose was observed with small antlers. Using these numbers, 14 calves: 100 Adults (c:A) were observed, a substantial improvement from the last survey of 4 (c:A). Alternatively, we observed 13% calves compared with the last survey which found 4% calves (Figure 1).

Moose were observed in close proximity to riparian areas. The largest congregations were on Kanak Island, which may be an important wintering area, and on the Edwardes River (Figure 2). Comparing the moose locations between the last survey in RY08 and this year's effort, moose appeared to use coastal areas such as Okalee spit and the Campbell River Delta to a lesser degree. This may be a product of snow caused movements.

The most meaningful measure of recruitment is calves:100 cows (c:C) but fall composition data is very difficult to achieve. Inadequate snow combined with diminishing daylight and distance from the nearest airport (50 minutes to the survey area), make this area particularly difficult. The last composition survey of the area was in 2009 when 15 c:C and 20 Bulls: 100 Cows (B:C) were observed. The previous two surveys in RY03 and RY05 found 19 B:C and 18 B:C respectively. The 20 year average harvest rate for the area was 6% (σ=1.7). In the absence of survey datapoints, a stable population is assumed. The maximum allowable harvest (MAH) for this area has not been reached since 2005. This may be somewhat driven by the availability of bulls. However, this hunt area is very remote and is mostly accessed using seine boats carrying jet or air boats. Access is likely the largest contributor to harvest. Additionally with a record high population in Unit 6C, and a stable population in Unit 6B, many households in Cordova may have their moose needs met.

A number of factors may have influenced the improvement in c:A. Fall composition surveys in Unit 6B (2014) and Unit 6C (2013) found the proportion of calves to be the highest observed since the population came out of its irruptive period in the late 1970s, (36c:C and 49 c:C respectively). This calf retention may be related to summer range conditions after abnormally warm summers. The spring population estimate in Units 6B and 6C also found adequate and strong recruitment respectively (17 c:A and 25 c:A). Another factor may be that snow depths the last two winters have been far below average based on Cordova observations and Yakutat weather station data (nearest collection site) (Figure 3). From an energetic standpoint, moose are less taxed by shallow snow depths (Coady 1974). Numerous studies have documented increased wolf predation in deep snow (Kolenosky 1972, Peterson and Allen 1974, Haber 1977, and Nelson and Mech 1986). Additionally, several studies have found increased predation of calves during periods of deep snow (Peterson 1977, and Ballard et al. 1987). Others found no difference between calf predation between snow categories (Haber, 1977) or that calves were preyed upon more heavily during intermediate snow and predation on adult animals increased with deeper snow (Huggard 1993). Many of the differences between these studies can be explained by the definition of snow categories (low, intermediate, and severe) which differ among areas. Most studies considered 75cm to be the limiting snow depth. However, snow depths in Unit 6A West may have only reached that level once in the last 20 years (Figure 3.)

Historical records suggest that few wolves existed south of the Bremner River before the introduction of moose on the Copper River Delta. Those that did venture down were probably food limited and had a diet of salmon and goats (Carnes, 2004). By the 1970s, regular but small harvest was occurring in the Bering River area. In the mid-1980s a pack of about 15 wolves were observed in unit 6A West (H. Griese, Pers comm.) No large packs (>10 wolves) existed in the area from RY93-RY96 (Carnes 2004). Since at least the mid-2000s, stakeholders have expressed concerns of a growing population of wolves in the area. No wolf population estimates exist for this area and harvest has been light. For the last 10 years 1-3 wolves have been taken from this area annually. So far this year however, 14 wolves have sealed from this area. This may represent about 50% of the wolves in that area based on biweekly aerial tracking by a local trapper. Most of these animals were taken in February. It is unclear if this harvest pressure has affected moose survival to a meaningful degree. Mean moose kill rates for wolves in Unit 6, (0.54-0.92 moose/wolf/100 days) were low compared to other areas of Alaska (Carnes 2004). Additionally moose in Unit 6 had more diverse diets than anything previously documented. Although moose were the most important food item, wolves also relied heavily on beaver and salmon even in winter months (Carnes 2004).

Population estimates for Unit 6A (West and East) will remain a priority until it is completed. The last estimate was below objectives and with very poor recruitment. Since this hunt utilizes a harvest quota, it is imperative that a good estimate is achieved to assess an appropriate harvest rate. This area should be surveyed on a biannual or triannual basis.

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Table 1: Unit 6A West Spring Survey Data (2002-2015).

Survey date	Population Estimate	90% CI	Calves: 100 Adults	Calves (%)	Moose Observed
02/20/02	297	236-358	15	15	253
01/31/06	275	238-311	18	16	206
01/31/08	276	249-301	7	7	232
02/14/09	245	212-279	4	4	194
03/11/15			14	13	160

Figure 1:

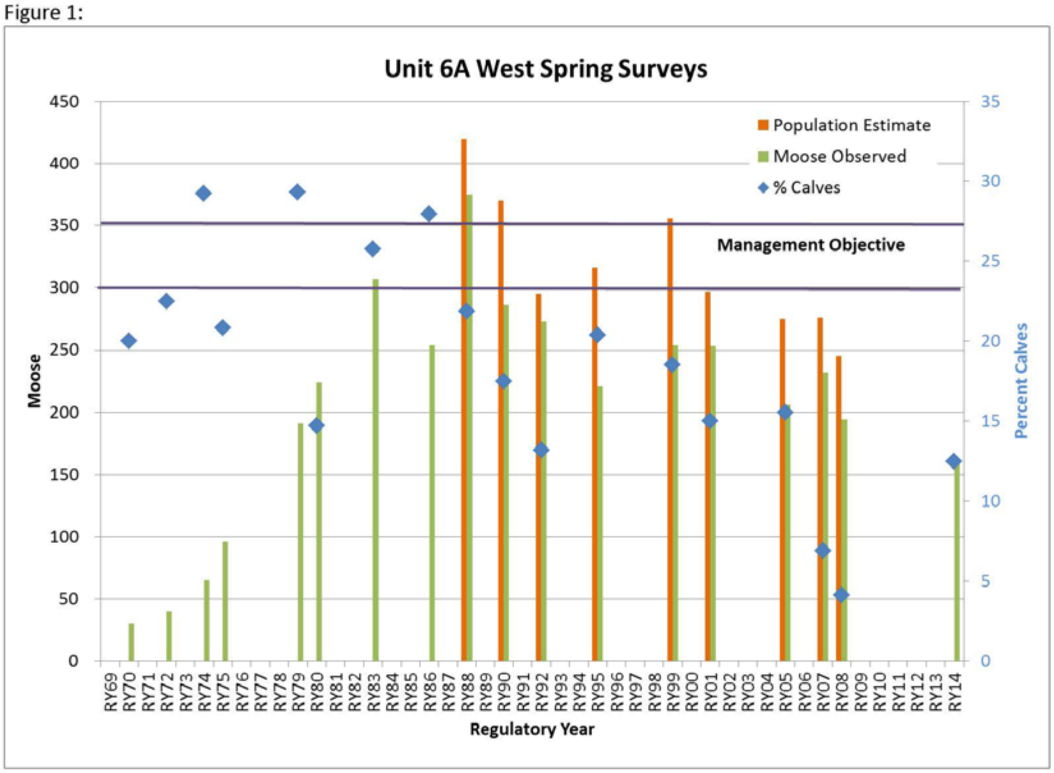


Figure 2:

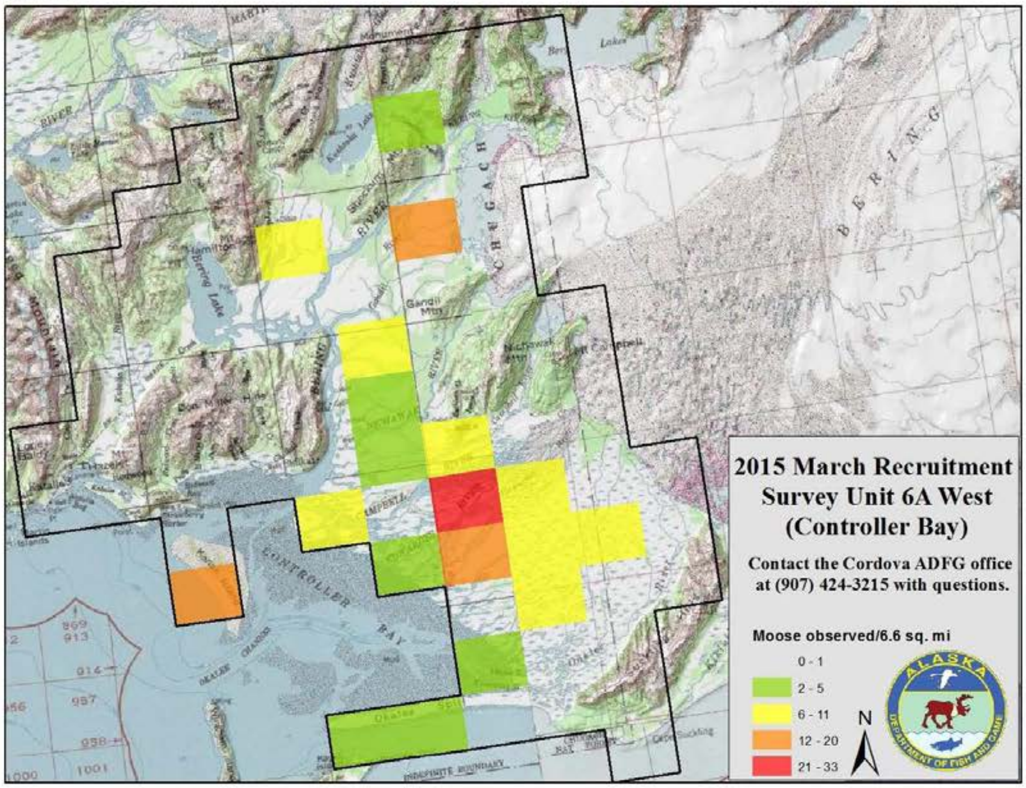
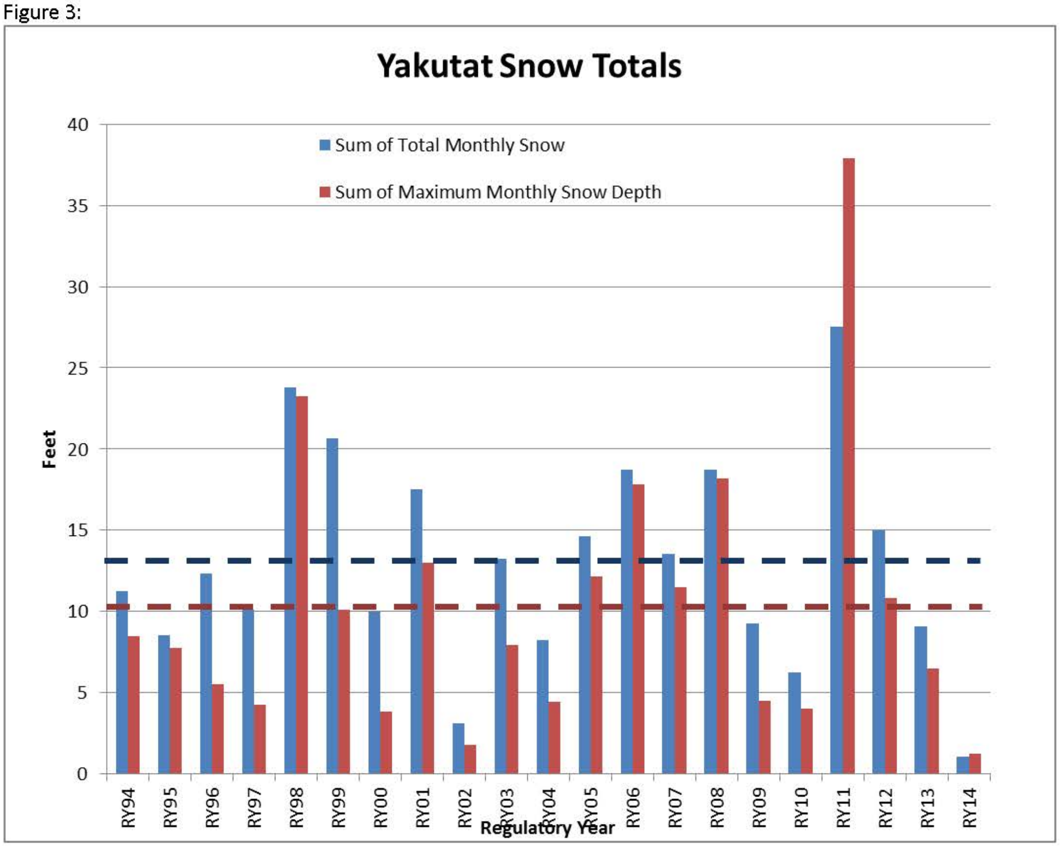

2015 March Recruitment
Survey Unit 6A West
(Controller Bay)
Contact the Cordova ADFG office
at (907) 424-3215 with questions.
Moose observed/6.6 sq. mi
0 - 1
2 - 5
6 - 11
12 - 20
21 - 33
N
ALASKA
DEPARTMENT OF FISH AND GAME
CONTROLLER
BAY

Figure 3:


Yakutat Snow Totals
Sum of Total Monthly Snow
Sum of Maximum Monthly Snow Depth
Feet
0
5
10
15
20
25
30
35
40
RY94
RY95
RY96
RY97
RY98
RY99
RY00
RY01
RY02
RY03
RY04
RY05
RY06
RY07
RY08
RY09
RY10
RY11
RY12
RY13
RY14
Regulatory Year

Appendix C. Regulatory year 2013 fall moose composition survey, Unit 6C, Alaska.

THE STATE *of* ALASKA

GOVERNOR SEAN PARNELL

Department of Fish and Game

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December 19, 2013

MEMORANDUM

To: Gino Del Frate
Management Coordinator
Anchorage

From: Charlotte Westing
Wildlife Biologist III
Wildlife Conservation Division
Cordova

Subject: Completion of moose composition surveys in GMU 6C, west Copper River Delta

INTRODUCTION

Moose populations in most of Unit 6 originated from translocations of calves from the Kenai Peninsula, Anchorage, and the Matanuska-Susitna area (Paul 2009). Hunting in Unit 6C (West Copper River Delta) began with 25 bulls harvested in 1960. Since that time, about 70 moose (26% cows) are taken annually from the subunit. Composition surveys are an essential management tool to calculate appropriate bull quotas and monitor the potential effects of selective harvest. In addition to Bulls:100 Cows (B:C) data, calves:100 Cows (c:C) data is collected. This metric can be used to understand potential impact of predation and when compared with a spring population estimate, can be used to understand winter mortality. Depressed B:C ratios have been found to affect the fecundity of primiparous moose (Solberg et. al, 2002) and have been related to a delay in mean parturition date which may influence the winter survival of calves (Sæther, et al., 2003). Composition data was regularly collected nearly annually from the early 1960s until the late 1980s. No data were collected from 1991 to 2003. From 2004 to present, composition data was collected every 1-3 years when the fall conditions allowed for surveys. Fall composition survey data is an essential component of managing sustainable moose hunts.

METHODS

We conduct aerial surveys to estimate fall moose population composition in November when 6-8 inches of snow increases sightability (Crowley 2010). In some years, requisite snow does not occur by the time antlers begin to shed in early December. This year, we flew surveys in Piper Super Cub aircraft (PA-18, piloted by Mike Collins with Charlotte Westing as observer) at between 300 and 800 feet above ground level. Between 6-8 inches of snow had been deposited however, some areas were wind-blown. Survey techniques this year used a random sample of units (approximately 5 square miles) within the Geospatial Population Estimate (GSPE) survey protocol. We surveyed 20 of 47 sample units, a 40% sample size (Figure 1). Sample unit order was determined by a randomly generated order with modifications for weather when necessary. However, all selected units were ultimately sampled. Moose seen in transit or outside of sampled units were also counted and classified but were withheld from GSPE analysis. Moose were classified as yearling (spike/fork), medium (<50 inch antler spread), and large (>50 inch antler spread.) Cows were classified as either a cow without calf, cow with one calf, or cow with two calves. Prior to 2009 bulls were only classified as either yearling or >2 year old. Waypoints were taken for groups of animals to record distribution and determine inclusion in GSPE analysis. Observations of other wildlife were also recorded such as coyotes.

Data that was collected in selected sample units were analyzed using the GSPE analysis tool in Winfonet. Stratification is generally used to increase efficiency by focusing more efforts in areas where moose occur and to increase estimate precision. In the case of this survey, conditions and budgets were not conducive to flying stratification surveys and desktop stratification was likely to lead to misclassification. Therefore, a universal stratification was applied to all units due to the high likelihood of moose presence. The web interface for GSPE analysis is not designed to run using single stratification scheme. A "dummy" stratification was created to allow for the analysis. This was done by selected units outside the survey area for consideration in the survey but designating them as a separate analysis area as per the advice of the analyst/programmer responsible for the Winfonet tool.

RESULTS AND DISCUSSION

Surveys were performed on November 29 (5.25 hours) and December 2 (5.5 hours). Search time varied as influenced by habitat and the presence of moose. Average search intensity was 5 minutes per square mile.

By survey completion, 255 moose were observed (Table 1). Sixty-three of these moose were bulls, 129 were cows, and 63 were calves. Using these numbers, 49 Bulls: 100 Cows (B:C) and 49 calves: 100 Cows (c:C) were observed.

Using the geospatial population estimator (GSPE) allows for the generation of measures of precision. For the GSPE analysis, 192 moose were considered. Using only these numbers, 53 B:Cows and 49 c: C were observed. The model generated a B:C ratio of 64 with a 95% Confidence Interval of 30-97. The model also generated a c:C ratio of 50 with a 95% Confidence Interval of 17-83. Therefore, all aforementioned scenarios are encompassed by the confidence intervals.

From 2006-2009, the bull harvest may have been too liberal with B:C ratios documented as low as 14 B:C in 2009 (Crowley, 2010). Anecdotal evidence confirmed a drop in the number of bulls in the population and antler spread data also reflected that perhaps fewer large bulls were available for harvest (Figure 2) (Milo Burcham, pers. com, USFS, Cordova). As a result of these data, adjustments were made in quotas to allow for growth in the bull component of the population. In 2009 and 2010 when bulls were classified into the three categories also used in the 2013 survey, there was a preponderance of yearling bulls. However in 2013, 54% of observed bulls were medium, 25% were large and 21% were yearling bulls (Figure 3).

Calf:Cow ratios were the highest observed since the late 1970s when the population was coming out of its irruptive period. Of the parturient cows, 19% had twins compared with 6% in 2010 and 12% in 2009. Random sample unit selection addressed the potential for bias in the 2013 survey with respect to which areas were examined for moose. Prior to 2013, data were collected by minimum count with a goal to classify at least 200 moose. Minimum count techniques of the past may have been biased against finding calf/cow groupings and biased towards larger congregations of moose. The possibility also exists that more calves were produced related to the extreme weather experienced in the winter of 2011-2012 however, none of the calf data from other survey work supports that result. The most likely factor influencing the number high B:C and c:C ratios, is the high harvest of cows this hunting season (50 cows taken thus far.) Future adjustments to allow for more bull harvest should take pre-hunting as well as post-hunting numbers into consideration to avoid overharvest of the bull segment of the population.

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SÆTHER, B.E., SOLBERG, E.J., AND HEIM, M. 2003. Effects of Altering Sex Ratio Structure on the Demography of an Isolated Moose Population. The Journal of Wildlife Management. Vol. 67, No. 3, pp. 455-466.

SOLBERG, E.J., LOISON, A., RINGSBY, T.H., SÆTHER, B-E. & HEIM, M. 2002. Biased adult sex ratio can affect fecundity in primiparous moose Alces alces. Wildlife Biology 8: 117-128.

Table 1: Moose classified in fall composition surveys in 6C from 2003-2013.

Survey date	Yrlg bulls	Medium bulls	Large bulls	Bulls >2 yrs	Cows	Calves	Unk	B:C	c: C	Calves (%)	Total
11/13/03	29			26	88	9	0	63	10	6	146
12/1/05	13			32	151	44	0	30	29	18	240
11/30/07	14			16	83	14	0	36	17	11	129
11/16/09	18	9	6	15	230	34	1	14	15	11	298
12/2/10	28	9	3	12	183	35	0	22	19	14	258
12/2/13	13	34	16	50	129	63	0	49	49	25	255

Figure 1:

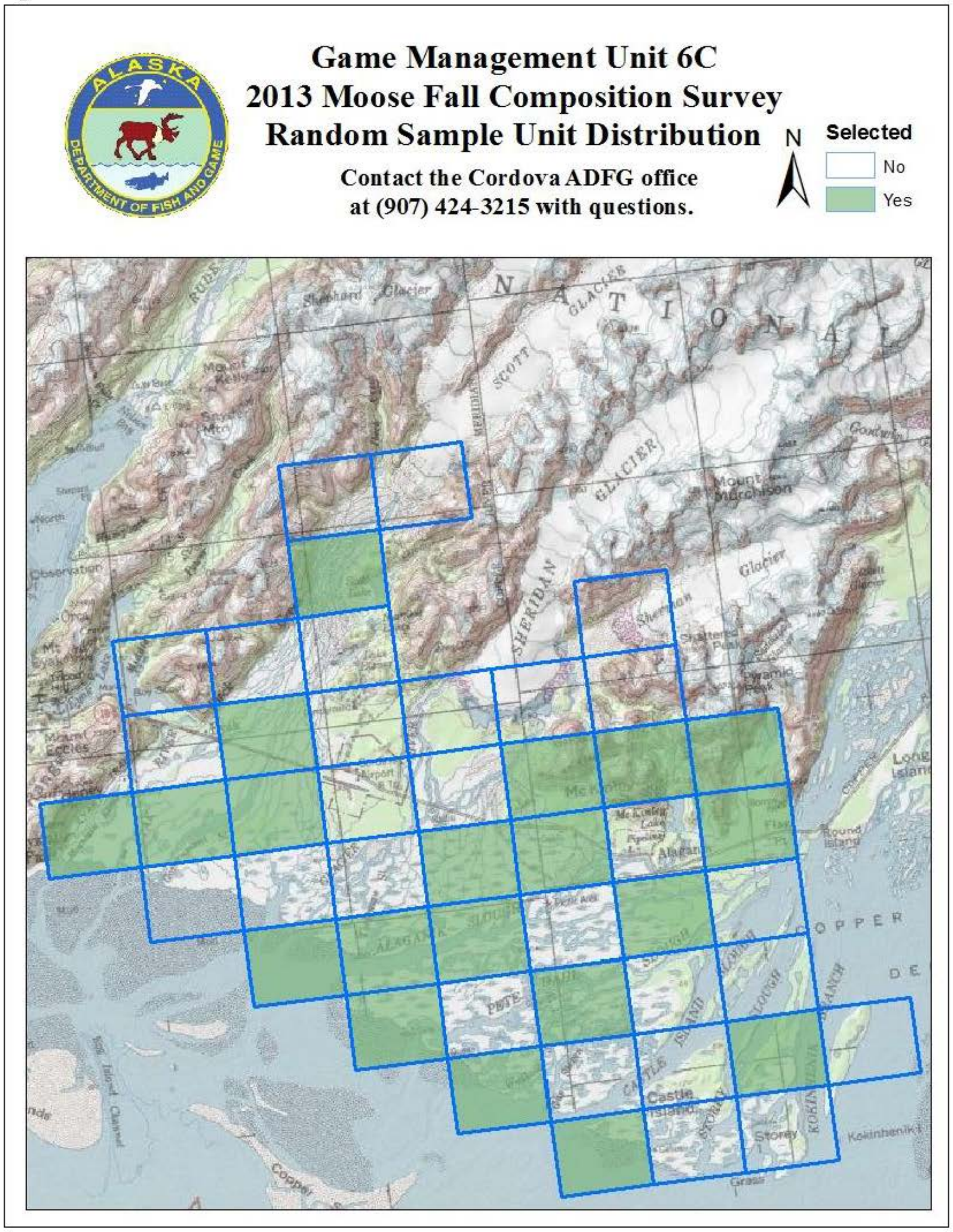

Game Management Unit 6C
2013 Moose Fall Composition Survey
Random Sample Unit Distribution
Contact the Cordova ADFG office
at (907) 424-3215 with questions.
N
Selected
No
Yes
ALASKA
DEPARTMENT OF FISH AND GAME
SHERIDAN
GLACIER
Mount Murchison
Castle Island
Storey
COPPER

Figure 2: Average antler spread for bulls taken in the 6C federal hunt

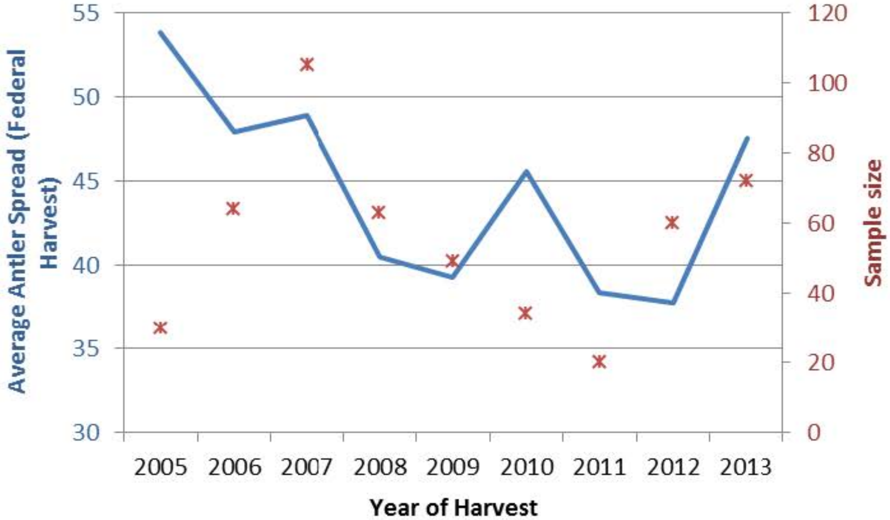
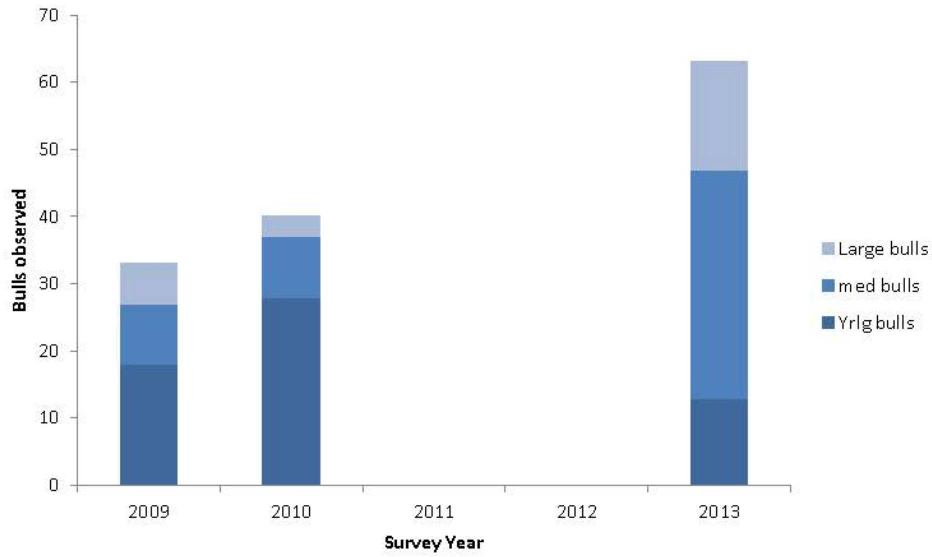


Figure 3: Size distribution of observed bulls in 6C.



Appendix D. Regulatory year 2014 fall composition survey, Unit 6B, Alaska.

THE STATE of ALASKA

GOVERNOR BILL WALKER

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December 31, 2014

MEMORANDUM

To: Gino Del Frate
Management Coordinator
Anchorage

From: Charlotte Westing
Wildlife Biologist III
Wildlife Conservation Division
Cordova

Subject: Completion of moose composition surveys in GMU 6B, east Copper River drainages including the Martin River

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INTRODUCTION

Moose populations in most of Unit 6 originated from translocations of calves from the Kenai Peninsula, Anchorage, and the Matanuska-Susitna area conducted from 1948- 1958(Paul 2009). Hunting in Unit 6B (east Copper River Drainages) began in 1965. Since that time, about 24 moose are taken annually from the subunit. Cow hunts have not been held in Unit 6B since 1998, the last time the population was within its objective of 300-350 moose. Composition surveys are an essential management tool to calculate appropriate bull quotas and monitor the potential effects of selective harvest. In addition to Bulls:100 Cows (B:C) data, calves:100 Cows (c:C) data is collected. This metric can be used to understand potential impact of predation and when compared with a spring population estimate, can be used to understand winter mortality. Depressed B:C ratios have been found to affect the fecundity of primiparous moose (Solberg et. al, 2002) and have been related to a delay in mean parturition date which may influence the winter survival of calves (Sæther, et al., 2003). Composition data was regularly collected nearly annually from the early 1960s until the mid-1980s. No data were collected from 1986 to 1993. From 1994 to present, composition data was collected every 2-9 years when the fall conditions allowed for surveys. The last survey prior to this one was in 2005. Fall composition survey data is an essential component of managing sustainable moose hunts.

METHODS

We conduct aerial surveys to estimate fall moose population composition in November when snow increases sightability (Crowley 2010). In some years, requisite snow does not occur by the time antlers begin to shed in early December. This year, we flew surveys in Piper Super Cub aircraft (PA-18, piloted by Mike Collins with Charlotte Westing as observer) at between 300 and 800 feet above ground level.

Between 3-5 inches of snow had been deposited atop heavy hoar frost. Coverage was relatively consistent and without patches of exposed vegetation except where moose had bedded down. Light conditions were ideal. Survey techniques this year used a stratified random sample of units (approximately 6 square miles) within the Geospatial Population Estimate (GSPE) survey protocol using the stratification from the spring population estimate survey. This technique is preferable to unstructured sampling which can lead to bias towards large groups of animals which are weighted towards cows. We surveyed 15 of 76 sample units, a 20% sample size (Figure 1). Thirty units were selected based on an 80/20 split between highs and lows respectively. Sample unit order was determined by a randomly generated order with modifications for weather when necessary. Some units were not done despite their priority due to high winds down the Copper River Valley. Moose seen in transit or outside of sampled units were also counted and classified but were indicated as such so they could be separated for analysis. Bulls were classified as yearling (spike/fork), medium (<50 inch antler spread), and large (>50 inch antler spread.) Cows were classified as either a cow without calf, cow with one calf, or cow with two calves. Prior to 2009 bulls were only classified as either yearling or >2 year old. Waypoints were taken for groups of animals to record distribution and determine inclusion in GSPE analysis if deemed appropriate. Observations of other wildlife were also recorded such as coyotes and bears.

RESULTS AND DISCUSSION

The survey was performed on November 30 (6.5 hours). Search time varied as influenced by habitat and the presence of moose. Average search intensity was 3 minutes per square mile.

By survey completion, 102 moose were observed, 45% of the spring 2014 estimate of 227 moose. (Table 1). Twelve of these moose were bulls, 66 were cows, and 24 were calves. Using these numbers, 18 Bulls: 100 Cows (B:C) and 36 calves: 100 Cows (c:C) were observed.

It is important to note that 75% of the bulls that were observed (nearly all of those in the Medium and Large category) were one-antlered. This suggests that antler cast may have been premature this year. There is the possibility that some antlerless bulls may have been classified as cows. The extent to which this is the case is unknown. However, the high number of calves observed relative to cows (36 calves: 100 cows) suggests that little misclassification occurred. Previous surveys showed a low proportion of one-antlered bulls (one or two observed per survey). However, last year's composition survey (conducted November 29 and December 2) on the West Copper River Delta had 30% one-antlered bulls.

This early antler cast observation seems a very significant departure from the norm. A standard rule of thumb for fall survey completion is a December 1st deadline which should avoid most early antler cast. Classifications of over 30,000 moose using aerial surveys in Canada have never found such early antler casting (Dr. Vince Crichton, personal communication.) Moose surveys conducted over many years in Alaska have also never turned up significant early antler cast (Jim Dau, Kris Hundertmark, Jeff Selinger, and John Crouse, personal communication). Those moose that lose antlers prematurely are expected to be in the large (>50 inches) category. In the case of this survey, all of large bulls classified had just one antler but 85% of the medium bulls (> than spike fork but <50 inch antler spread) were also one antlered. Because surveys in this area have not been performed at regular intervals or with much frequency, there is simply too little data to attempt to understand if early antler cast is regularly observed or variable related to annual conditions.

While little is known about factors that influence antler cast, it is largely thought to be influenced by photoperiod and nutrition. Moose on the Copper River Delta appear to have a higher than expected rate of abnormal antler formation. It has also been observed that a high proportion of antler sheds retained a portion of the pedicle bone. MacCracken et al. 1994, explored factors influencing observed "peculiar" antler cast. MacCracken et al. tested antler sheds for differences in iron (Fe) and Phosphorus (P) between antlers with or without retained pedicle bone. They found significant differences between these groups and thought it might be related to the availability of these elements in aquatic vegetation. These minerals were thought to influence the density and strength of the bone. This has never been further tested except to further document the retention of the pedicle bone on shed antlers. Another possible cause of early antler cast may be that moose are conducting an earlier rut.

The number of bulls in this area is lower than 2005 when 45 Bulls: 100 Cows were observed. From 2004-2010, the bull harvest may have been too liberal with harvest rates exceeding 10% in all years (13% average). Anecdotal reports indicate that there are fewer bulls and fewer big bulls than there were 10 years ago. These reports are supported by antler spread data which shows a decreased average antler spread for the last 4 years (Figure 2).

Calf:Cow ratios were the highest observed since the late 1970s when the population was coming out of its irruptive period. This suggests that the despite the low number of bulls observed, cows are being bred. Of the parturient cows, 9% had twins compared with 14% in 2003 and 13% in 2005. Random sample unit selection addressed the potential for bias in the 2014 survey with respect to which areas were examined for moose. Prior to 2014, data were collected by minimum count with a goal to classify at least 100 moose. Minimum count techniques of the past may have been biased against finding calf/cow groupings and biased towards larger congregations of moose. The possibility also exists that more calves were produced this year. The high calf:cow ratio suggests that a large number of bulls were not misclassified.

Composition surveys should be conducted more regularly (every 1-3 years) to allow for quicker response time as the population or its composition changes. More consistent composition surveys will also provide greater understanding of calf survival to fall and timing of antler cast. If early antler cast is regularly observed, it may require more evaluation to determine how to achieve the most accurate composition data possible.

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SÆTHER, B.E., SOLBERG, E.J., AND HEIM, M. 2003. Effects of Altering Sex Ratio Structure on the Demography of an Isolated Moose Population. The Journal of Wildlife Management. Vol. 67, No. 3, pp. 455-466.

SOLBERG, E.J., LOISON, A., RINGSBY, T.H., SÆTHER, B-E. & HEIM, M. 2002. Biased adult sex ratio can affect fecundity in primiparous moose Alces alces. Wildlife Biology 8: 117-128.

Table 1: Moose classified in fall composition surveys in 6B from 1994-2014.

Survey date	Yrlg bulls	Medium bulls	Large bulls	Bulls >2 yrs	Cows	Calves	Unk	B:C	c: C	Calves (%)	Total
11/16/94	10			19	135	18	0	22	14	10	182
11/27/99	6			22	154	8	0	18	5	6	190
11/25/03	10	20	14	34	72	8	0	61	11	6	124
12/02/05	9	10	16	26	77	17	0	45	22	13	129
11/30/14	3	7	2	9	66	24	0	18	36	24	102

Figure 1:

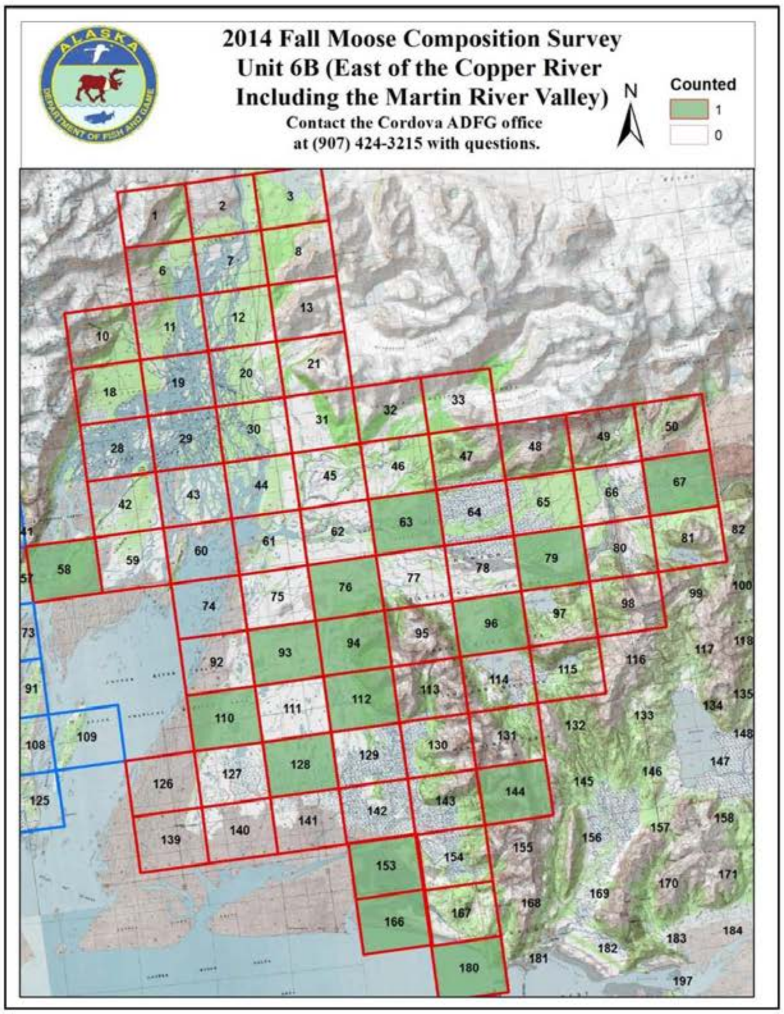
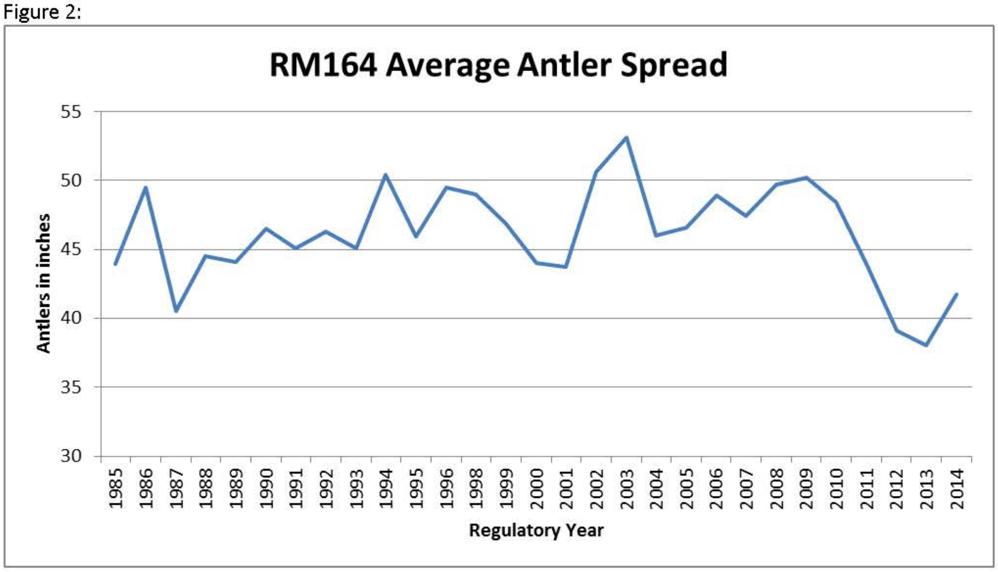


Figure 2:


RM164 Average Antler Spread
55
50
45
40
35
30
Antlers in inches
1985
1986
1987
1988
1989
1990
1991
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1994
1995
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2007
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2011
2012
2013
2014
Regulatory Year

Appendix E. Regulatory year 2013 moose twinning survey, Unit 6, Alaska.

THE STATE *of* ALASKA
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July 17, 2013

MEMORANDUM

To: Gino Del Frate
Region II Management Coordinator
Wildlife Conservation Division
Anchorage

From: Charlotte Westing
Prince William Sound Area Wildlife Biologist
Wildlife Conservation Division
Cordova

Project Report: Determination of Moose Twinning Rate on the Copper River Delta, 2013

INTRODUCTION

Moose twinning rates have proven to be an effective index of winter browse utilization in various moose populations of Interior Alaska (Boertje et al., 2007). Low twinning rates indicate probable over-browsing, i.e., a high proportion of current annual growth (CAG) is being consumed and cow moose are nutritionally stressed. This method has been verified by vegetation analysis conducted during late winter. Although twinning rates need not be determined annually, multiple years of surveys are recommended because of annual variability.

ADFG has completed twinning surveys on the western Copper River Delta (west delta) since the spring of 2007. Our long-range goal is to collect several years of twinning rates and combine those data with vegetation analysis performed by cooperators on the west delta to determine CAG consumption by moose. The vegetation analysis can also benefit the hydro-axing project being done by the Cordova Ranger District and Native Village of Eyak.

METHODS

We conducted moose twinning surveys using a Piper Supercub PA 18 airplane flown at low level (200 – 600 ft above ground level), searching brush lines bordering large meadows and stream braids on the west delta (Game Management Unit 6C). We flew surveys of the western Copper River Delta on 5/21, 5/23, and 5/29. The period was characterized by abnormally sunny and hot conditions although we experienced a bit of coastal fog. The objective of each survey was to see as many parturient cows as possible. Radio collars were not used for these surveys, however collars were noted when seen. Each moose observed was classified based on sex and parturition status, e.g. bull, yearling, and cow w/ 0, 1, or 2 calves. Moose observations, weather, visibility and relative moose activity were recorded on data forms. Survey tracks and locations of moose were marked and mapped using a GPS unit.

Twinning rates were calculated based on peak twinning which takes multiple flights to determine and were also calculated cumulatively. Surveys were flown in the morning or evening with calm winds and limited precipitation, which were the most likely conditions for cows with calves to be active and visible. Our sample goal was 30 parturient cows in one survey, however, data can also be considered cumulatively since it is proportional. Twinning rates were calculated as: 100* (cows with 2 calves / all cows with calves).

RESULTS AND DISCUSSION

The May 29, 2013 survey was likely very close to peak twinning and yielded 21 parturient cows. The goal of 30 parturient cows in one survey was not achieved. However, we were plagued by fog which precluded our access to the grass banks where we had observed parturient cows on previous days. Had that not been the case, the sample objective would have been achieved. Table 1 presents data for each survey and estimates from previous years. I estimate a cumulative twinning rate of 50% (95% CI of 35-65 assuming normal binomial distribution.)

We observed 347 moose in three days of survey work. Figure 1 shows the distribution of moose observed. I believe that observed and actual twinning rates were close. The decline of observed twinning rates may have occurred because of mortality (predation, thermal stress, and accidents) and decreasing sightability of calves as alder leafout progressed. However the timing of the surveys was ideal in terms of plant phenology and clear skies. The day of peak twinning, fewer moose may have been observed due to hot weather (temperatures in the 80s).

Peak twinning rates in 2013 are quite comparable to those observed in previous years (Table 1). Moose twinning rates in the west Copper Delta are among some of the highest observed in Alaska (Figure 1), implying excellent nutritional status of both moose and habitat. Although this seems to support the argument for increasing herd size on the west delta, the threshold level at which moose may begin impacting habitat is unknown for coastal populations. When moose density in Unit 20A (Tanana Flats) increased above approximately 1,000 moose/1,000 km^2 during the last decade, twinning rates decreased to 3-10% (Boertje et al., 2007). Managers are currently struggling to reduce herd size in the area to protect habitat. In contrast, moose density on the west delta has ranged from 1,250 – 1,900 moose/1000 km^2 since 2005 with as yet little indication of nutritional stress. MacCracken et al. (1997) provided a theoretical framework for moose carrying capacity on the west delta based on vegetation analysis. Our current management approach involves liberal cow hunting opportunity, attention to bull: cow ratios and monitoring for undue habitat pressure.

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Table 1: Twinning survey data for the west Copper River Delta (GMU6C), 2007-2013

	Cows			Total	%	Hours	Twinning
Date	0 calf[a]	1 calf	2 calf	moose[b]	calves	searched	rate
5/21/2013	61	5	5	93	16	4	50.0
5/23/2013	102	5	6	146	12	7	54.5
5/29/2013	57	11	10	108	29	7	47.6
5/23/2012	46	7	5	78	22	6.4	41.7
5/28/2012	66	13	12	142	26	3.75	48.0
5/26/2009	21	2	4	45	22	2.5	66.7
5/28/2009	40	8	7	82	27	2.7	46.7
5/29/2008	46	8	11	103	29	3.75	57.9
6/7/2008	13	3	3	41	22	3	50.0
5/26/2007	41	4	8	91	22	3.5	66.7
6/12/2007	50	3	5	84	15	3.3	62.5

[a] Cows with 0 calf likely includes yearling bulls and cows that are likely to be misclassified.
[b] Total moose includes yearlings and bulls.

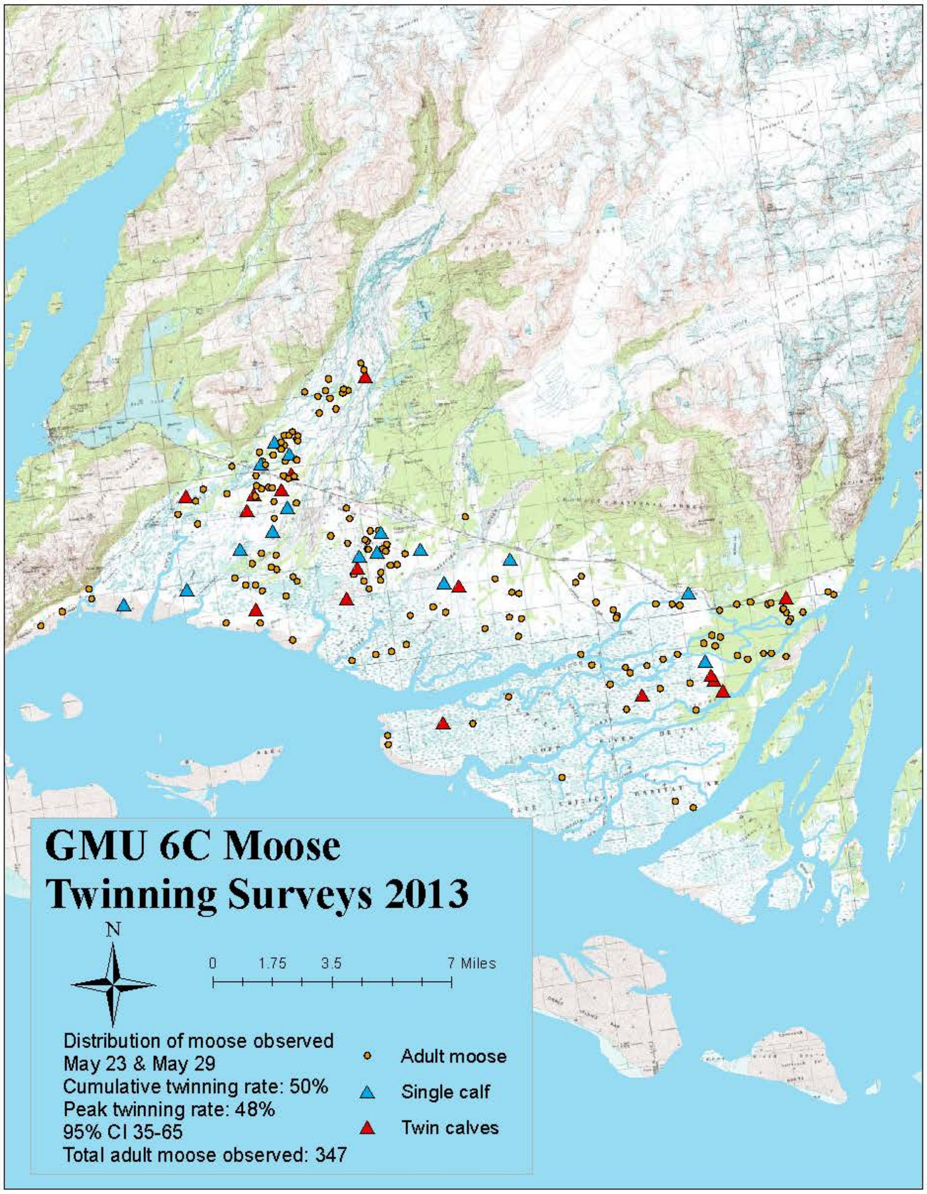

Figure 1. Distribution of moose observed during twinning survey, May 2013 in the west Copper River Delta.