Species Management Report and Plan ADF&G/DWC/SMR&P–2018–49

Moose Management Report and Plan, Game Management Unit 17:

Report Period 1 July 2010–30 June 2015, and

Plan Period 1 July 2015–30 June 2020

Neil L. Barten

2018

Alaska Department of Fish and Game Division of Wildlife Conservation

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

This species management report and plan was reviewed and approved for publication by Todd A. Rinaldi, Management Coordinator for Region IV for the Division of Wildlife Conservation, Palmer.

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Purpose of this Report

This report provides a record of survey and inventory management activities for moose in Unit 17 for the previous 5 regulatory years (RY; RY10–RY14) and plans for survey and inventory management activities in the 5 years following the end of that period (RY15–RY19). A regulatory year begins 1 July and ends 30 June (e.g., RY10 = 1 July 2010–30 June 2011). This report is produced primarily to provide agency staff with data and analysis to help guide and record its own efforts but is also provided to the public to inform them of wildlife management activities. In 2016 the Alaska Department of Fish and Game's Division of Wildlife Conservation launched this new type of 5-year report to more efficiently report on trends in data and describe potential changes in data collection activities over the next 5 years. It replaces the moose management reports of survey and inventory activities that were previously produced every 2 years.

I. RY10–RY14 Management Report

Management Area

Unit 17 is located in Southwest Alaska and consists of drainages into Bristol Bay and the Bering Sea between Etolin Point and Cape Newenham, and all islands between these points, including Hagemeister Island and the Walrus Islands (Fig. 1). Unit 17 encompasses diverse habitats ranging from several mountain ranges (Ahklun Mountains, Wood River Mountains, and Neacola Mountains), to the Nushagak Hills that make up the northern portion of Unit 17B, to large expanses of wet meadow and tundra habitat scattered throughout the unit. Unit 17B is defined by 2 large river systems, the Nushagak and Mulchatna Rivers that converge near the southern border of Unit 17B and continue on as the Nushagak River, defining a major portion of Unit 17C. These river corridors contain excellent moose habitat with willows (*Salix* spp.), cottonwood (*Populus balsamifera*), alder (*Alnus* spp.), and spruce (*Picea* spp.). Numerous tributaries to the Nushagak and Mulchatna rivers provide additional riparian habitat that is utilized by moose. Adjacent to these stream corridors, the habitat changes quite rapidly from riparian to wet meadow and tundra that contain little of the woody vegetation that moose utilize during the winter months. Both Units 17B and 17C also contain fairly large areas of spruce and mixed birch (*Betula* spp.) and spruce forests. The western edge of both Units 17B and 17C is dominated by the Wood River Mountains and a series of large lakes that are sandwiched between mountain peaks. Unit 17A though removed from the Mulchatna and Nushagak rivers, has a similar composition of riparian areas along stream corridors, wet meadow and tundra habitats away from the streams, and mountainous terrain. However, Unit 17A lacks the large expanses of spruce and mixed forest common to the other subunits; rather, shrubs of alder and willow are the dominant woody species in many habitats.

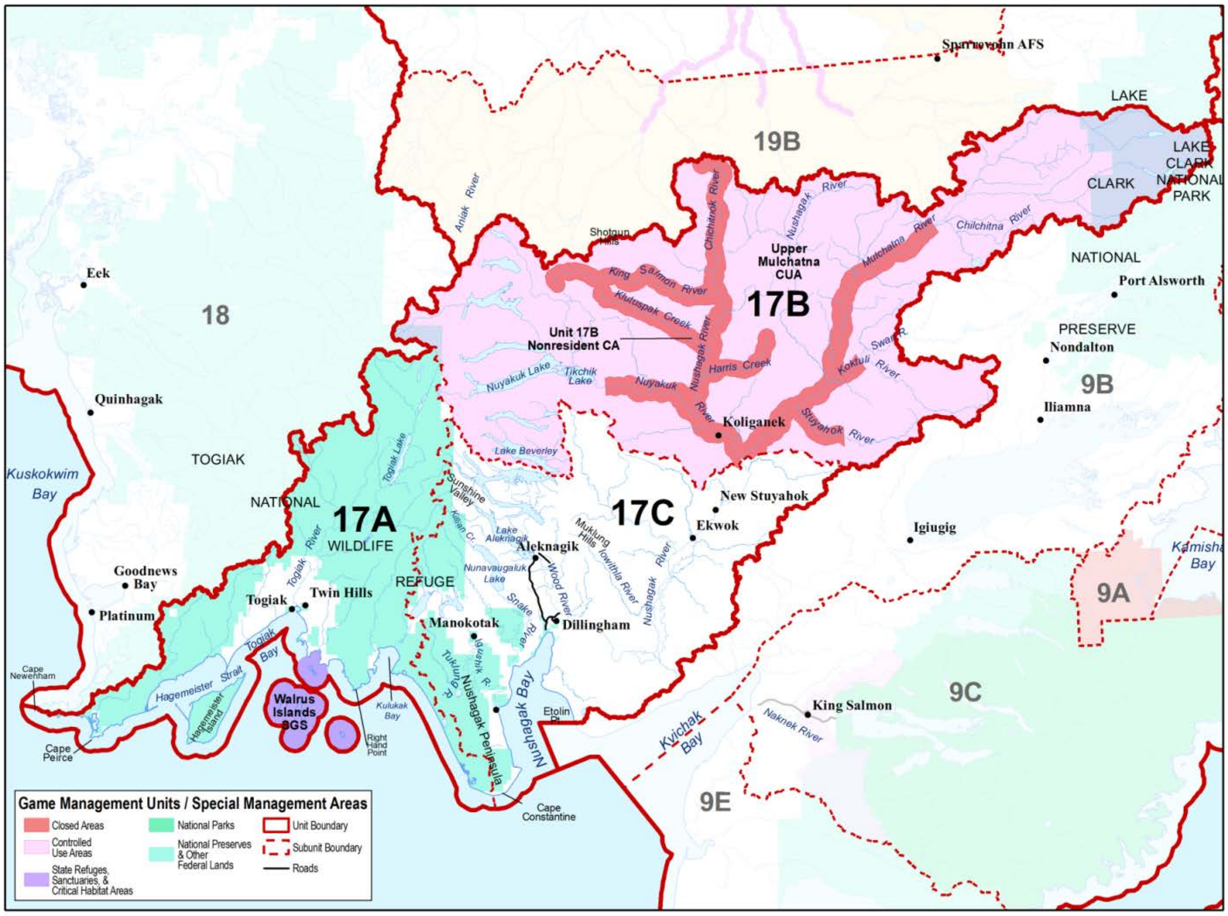

Figure 1. Unit 17 in Southwest Alaska.

Summary of Status, Trend, Management Activities, and History of Moose in Unit 17

Moose are relatively new inhabitants in the Bristol Bay area, possibly migrating from middle Kuskokwim River drainages. Until the 1980s, populations were low, and moose primarily inhabited the Nushagak-Mulchatna River system. Local residents harvested moose opportunistically; however, caribou, reindeer, bear, and beaver were historically the main sources of game meat. The Alaska Department of Fish and Game (ADF&G or department) began collecting data on the Unit 17 moose population in 1971. At that time, Faro (1973) reported moose were not abundant in the unit and animals close to the villages were subject to heavy hunting pressure.

Hunting seasons have varied over the years, but the legal bag limit had always been restricted to bulls until 2013 when a limited antlerless season was opened in Unit 17A. In the past, a general disregard for seasons and bag limits by unit residents was suspected to be the principal factor contributing to low densities of moose in the unit at a time when habitat conditions suggested moose should be increasing (Taylor 1990).

In the last 3 decades, moose populations throughout Unit 17 have increased substantially in number and range. Reasons for this increase likely include moderate snowfalls in several successive winters, and decreased harvest of female moose. The reduction in the female harvest resulted in part from a positive response by unit residents to department education efforts, and from the abundance of an alternative big game resource as the Mulchatna caribou herd grew and extended its range during the late 1980s to the mid-1990s (Van Daele 1995).

Moose are now common throughout the unit in areas of suitable habitat. Moose successfully extended their range westward into and beyond the Togiak river drainages of Unit 17A over the past 25 years, where a viable population has become established.

Management Direction

Existing Wildlife Management Plans

- The department's moose management plan for Unit 17 has been reviewed and modified over time based on public comment, staff recommendations, and Alaska Board of Game (BOG) actions. These periodic changes in management planning have been reported in the division's pervious species management reports. The plan portion of this report contains the current management plan for moose in Unit 17.
- Moose Management Plan for Game Management Unit 17A (Unit 17A Moose Management Group 2013; Appendix A). Interested stakeholders (Bristol Bay Federal Subsistence Regional Advisory Council, Nushagak and Togiak Fish and Game advisory committees, Togiak National Wildlife Refuge, and the Alaska Department of Fish and Game in Dillingham) worked together in 1996 to draft a Unit 17A moose management plan and have subsequently made revisions based on increasing moose abundance and associated changes in harvest pressure, desired hunter opportunity, and desired population levels. The latest revision to the plan was completed in 2013.

Goals

- Maintain healthy age and sex structures within unit 17 moose populations.
- Provide for maximum opportunity to participate in hunting moose.
- Provide for consumptive and nonconsumptive uses of moose populations.

Codified Objectives

<u>Amounts Reasonably Necessary for Subsistence Harvest</u>

- The Unit 17 moose population has a positive customary and traditional use determination finding. The unitwide amount reasonably necessary for subsistence value is 100–150 moose.

Intensive Management

In 2001 BOG adopted a positive finding for intensive management (IM) of moose in Units 17B and 17C (no positive finding in Unit 17A). Current IM objectives are as follows:

- Population objectives:
  - Unit 17B: 4,900–6,000
  - Unit 17C: 2,800–3,500

- Harvest objectives:
  - Unit 17B: 200–400
  - Unit 17C: 165–350

MANAGEMENT OBJECTIVES

Unit 17A

- Manage for a minimum population of 300 moose and a target population of 1,100–1,750 moose.

Unit 17B

- Manage for a population of 4,900–6,000 moose with a human use objective of 200–400 moose.
- Achieve and maintain a density of 1 moose/mi^2 on habitat considered good moose range.

Unit 17C

- Manage for a population of 2,800–3,500 moose with a human use objective of 165–350 moose.
- Maintain a minimum density of 0.5 moose/mi^2.

MANAGEMENT ACTIVITIES

Assessing population status and trends, monitoring harvest and mortality, and assessing habitat conditions are integral components of management programs in Unit 17. Survey and inventory management activities used to monitor moose populations in Unit 17 are described below and can be found in Woolington (2012) and for 2011 and 2012 in Barten (2014).

1. Population Status and Trend

ACTIVITY 1.1. Conduct aerial surveys to estimate moose abundance, composition, productivity, and trends in these indices.

Data Needs

Moose abundance and age-sex composition are integral components of moose management, and essential to determine if our IM objectives are being met. Although the geospatial population estimator (GSPE, DeLong 2006) is the most commonly used technique for estimating abundance in many areas of the state, surveys in Unit 17 have traditionally employed the Gasaway (Gasaway et al. 1986) model using MoosePop (Reed 1989) for analysis. This method as used in Unit 17 contained 4 strata for moose abundance and had been used since 1999. However, beginning in spring 2014 we transitioned away from the Gasaway technique to the more common GSPE methodology. These estimates are used for monitoring trends in abundance and productivity and for comparing the abundance against IM population objectives.

Methods

<u>Spring 2010</u>

We used the Gasaway survey method to survey the moose population in Unit 17B (West). Four strata (super-low, low, medium, and high) were used to classify moose abundance prior to the survey, with 830 units (approx. 6.5 mi^2 per unit, and 5,510 mi^2 in total area) classified (high: 30, medium: 98, low: 345, super-low: 357). Of these, 113 were surveyed (high: 30, medium 47, low: 29, super low: 7) with an area of 752 mi^2. The population estimate was 1,137 moose ± 159 (Table 1). This survey did not include a sightability correction factor (SCF).

<u>Spring 2011</u>

In cooperation with the Togiak National Wildlife Refuge (TNWR) a minimum count moose survey was conducted in Unit 17A. This included nearly all portions of Unit 17A except those areas west of the Osviak River drainage and the western portion of the Nushagak Peninsula. The survey was conducted during 1–4 March 2011; a total of 1,166 moose were observed in 29 survey hours, with an observation rate of 40 moose per hour. A minimum of 115 calves (including 13 sets of twins), or 10% of the overall count (Table 1), were observed (Aderman 2014).

<u>Spring 2014</u>

From 18–23 March 2014 we conducted a GSPE survey with SCF in Unit 17C. Although the Gasaway survey technique had been used in the past, the decision was made to transition to the GSPE method due to a greater familiarity and trust with this technique by newly acquired staff. Ninety-nine (99) of 764 sample units were surveyed. The uncorrected estimate (the same as previous years) resulted in an estimate of 4,053 moose ± 764 (Table 1). During this survey we conducted sightability correction surveys in a portion of the units for the first time, yielding a sightability corrected estimate (SCF = 1.14) of 4,642 moose (± 996 at 90% CI) including 650 calves representing 14% of total moose (±91 at 90% CI). We did not attempt to distinguish sex, but did categorize adults and calves.

Table 1. Unit 17 moose population estimation surveys, Southwest Alaska, regulatory years[a] 1998–2013.

Survey area	Regulatory year	Population estimate	Moose/ mi^2	Total survey mi^2	Moose habitat mi^2	Moose/mi^2 moose habitat	Minimum % calves
Unit 17B (west)[b]	2000	1,202 (± 141)	0.22	5,524	2,932	0.41	5
	2005	1,210 (± 120)	0.22	5,524	3,140	0.39	13
	2009	1,137 (± 159)	0.21	5,510	3,146	0.36	8
Unit 17B (east)[c]	2001	1,953 (± 254)	0.46	4,269	2,914	0.67	4
	2008[d]	1,466 (± 424)	0.37	3,981	2,913	0.50	8
Unit 17C	1998	2,955 (± 488)	0.54	5,447	3,795	0.78	15
	2003	3,670 (± 542)	0.67	5,447	4,096	0.90	11
	2007	3,235 (± 354)	0.59	5,447	4,280	0.76	12
	2013	4,053 (± 764)	0.78	5,208	4,280	0.95	14

[a] A regulatory year begins 1 July and ends 30 June (e.g., regulatory year 1998 = 1 July 1998–30 June 1999).
[b] That area of the Nushagak River drainage upstream of the confluence of the Nushagak and Mulchatna rivers.
[c] That area of the Mulchatna River drainage upstream of the confluence of the Nushagak and Mulchatna rivers. (Does not include that area of Lake Clark National Park within Unit 17B).
[d] Estimate for entire survey area, however high winds/turbulence prevented counting in some selected sample units, especially some considered High Density strata in riparian areas of the lower Mulchatna River.

Results and Discussion

Unit 17A has a negative finding for IM; however, Units 17B and 17C have positive findings. The IM population objective for Unit 17B is 4,900–6,000; however, because it is a large geographic area and because the opportunity to survey the unit is limited to short periods of time due to weather conditions, the unit was divided into east and west zones, and attempts are made to survey each zone on a 3-year cycle. Because of poor snow conditions in recent years our most recent survey in Unit 17B was conducted in spring 2010 and only covered the western zone, and therefore does not provide enough information to determine if our population objective within Unit 17B as a whole was met. Given that the estimate for this survey in Unit 17B west was 1,137 moose (Table 1) and the historical estimates for Unit 17B-east have been less than 2,000 animals, it is likely that the moose population is well below the IM population objectives for the unit (4,900–6,000 moose). In Unit 17C, the population estimate from spring 2014 of 4,642 (± 580) was above the IM population objective of 2,800–3,500 moose. The percentage of calves in all of these surveys has been relatively low and highlights the need to understand the factors leading to this. As a study plan is developed the next reporting period, options for gathering data on productivity and recruitment will be explored to better understand some of the basic population dynamics of Unit 17 moose.

In Unit 17A, the moose population has been increasing steadily since the early 1990s, and although the most recent survey was in 2011, all indications are that this moose population has remained productive and is likely increasing (Aderman 2014).

There is no objective for bull:cow ratios in this management report due to the lack of survey methodology to reliably estimate the composition of moose when there is no snow cover in the fall. As a result, moose surveys are conducted in the spring after the moose have dropped their antlers. An evaluation of harvest patterns (Table 2) indicate that the harvest of bull moose in Units 17B and 17C has declined steadily since the early 2000s and presents a concern about what caused the decline. Acquiring composition data to understand how well bulls are represented in our population is an important piece of data needed to assess the sustainability of the current seasons in Units 17B and 17C.

Table 2. Reported moose harvest data for all hunts in Unit 17, Southwest Alaska, regulatory years[a] 2000–2014.

Regulatory	Reported	Hunters	Success	Unit[b]			
year	harvest	Afield	rate (%)	17A	17B	17C	Unk
2000	373	1,112	34	10	226	136	1
2001	419	1,175	36	7	186	222	4
2002	404	1,147	35	8	183	210	3
2003	426	1,168	36	11	163	251	1
2004	383	1,204	32	20	168	193	2
2005	380	1,182	32	25	117	232	6
2006	384	1,103	35	36	113	233	2
2007	388	1,142	34	40	113	213	22
2008	353	1,230	29	45	79	229	0
2009	322	1,231	26	31	81	206	4
2010	343	1,289	27	37	75	151	80
2011	349	1,279	27	50	63	236	0
2012	302	1,281	23	46	55	200	1
2013	253	1,213	21	35	63	150	5
2014	281	1,059	27	52	62	165	2

[a] A regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2000 = 1 July 2000–30 June 2001).
[b] Only includes those moose reported to the subunit level of resolution.

Weather patterns during the past 3 years have provided only minimal snow cover that has hindered consistent survey opportunity, leading to sporadic data that do not allow for assessing trends in abundance to aid moose management decisions. Recently discussions about survey methodology have contemplated incorporating the use of a helicopter to determine population composition, similar to the technique being used by biologists in Minnesota and parts of Canada (Oswald 1997). In March 2015, this methodology was tested on approximately 80 moose on a section of the Iowithla River in Unit 17C, and moose were successfully categorized by sex and age. The next step before implementing this technique is to devise a survey strategy to minimize any bias in moose demographics to ensure we are assessing a random section of the population.

The recommendation is to continue with GSPE surveys and incorporate survey units to estimate SCF when practicable to provide for better estimates. This is especially critical if the snow conditions are less than ideal which has been the case in recent years. The GSPE surveys will alternate between Units 17C, 17B-west, and 17B-east every 3 years, while assisting the Togiak National Wildlife Refuge with surveys of Unit 17A on an every 2- to 3-year cycle.

A new methodology for acquiring composition data in concert with our abundance estimates should also be developed for this unit. This will take some experimentation in finding a methodology that provides both an adequate sample to derive composition, and a sample that is representative of the population.

Recommendations for Activity 1.1.

Modify.

ACTIVITY 1.2. Spring twinning surveys.

Data Needs

Estimates of moose nutritional condition and productivity are integral to management on a sustained yield basis over the long term and for supporting the goal of protecting moose health and habitat. Determining how many cows have twins relative to cows with singletons provides an indication of condition and productivity of the moose population. There is very little information about the moose populations in Units 17B and 17C to guide management, so gathering twinning data as a first step toward a comprehensive understanding of these moose populations would allow for an adaptive management strategy guided by population level data.

Methods

Twinning surveys were conducted in spring of 2012 and 2015 during this reporting period, but prior to that, twinning surveys had not been completed. This was due in part to the green up of vegetation that usually occurs prior to peak calving, making it difficult to detect cow moose and their neonates. However, by starting surveys early in the morning, it seems that enough females can be detected to provide a sufficient sample of cows with calves to assess twinning rate.

<u>Spring 2012</u>

Survey flights to estimate moose twinning rates were conducted on 31 May and 1 June 2012 using a PA-18 Super Cub, flying approximately 400–500 feet above ground level. The surveys were flown along the lower Nushagak River with no spatial overlap. Leaf out was well underway when the surveys occurred and influenced detectability. The moose observed were categorized as bull, yearling cow, adult cow without a calf, or adult cow with single or twin calves.

<u>Spring 2015</u>

Three survey flights were conducted along the lower Nushagak River from the junction with the Wood River, up to the Kokwok River, including the Kokwok, Muklung and Iowithla rivers. All of the data were collected from a PA-18 Super Cub, flying 400–500 feet above ground level. When a moose was spotted, we would usually conduct a closer pass to allow for maximum detection probability of a calf(s). The survey route was recorded on a GPS, and a waypoint with latitude and longitude was recorded for each moose seen. All moose observed were classified as bull, yearling cow, adult cow without a calf, or adult cow with single or twin calves (Appendix B). Twinning surveys were initiated on 19 May, and subsequent flights were conducted on 22 May, and 26 May. Each of these 3 surveys overlapped the lower Nushagak where most of the cow moose seemed to be residing. By overlapping the survey areas during all 3 surveys, we were able to get a better sense of when peak calving was occurring, and use this as a building block towards designing a survey protocol for future years.

Results and Discussion

During 2012, the twinning survey on 31 May resulted in the observation of 22 cows with calves, with 12 (55%) having twins. On 1 June, 16 cows were seen with calves, and 4 (25%) had twins. In 2015, the percent twins observed during the 3 survey days was 50%, 33%, and 60%, with sample sizes of 10, 12, and 20 cows observed with calves respectively. Although we are just beginning what we hope to see as a standard survey and inventory process of collecting twinning data, these 2 years of preliminary data provide a good framework for planning and designing future efforts.

Based on the percent of cows observed that had calves, the 2012 survey was probably closer to peak calving than the 2015 survey. In 2012, 109 cows were observed during the 2 days of surveys, of which 38 (35%) were seen with a calf. In 2015, 292 cows were observed during the 3 days of surveying, of which 42 (14%) were seen with a calf. Although the twinning rate for those females detected with calves has been promising for our small sample size, a concern is the overall number of females that are not accompanied by any calves. Whether this is a factor of our sampling design (using unmarked females), thick vegetation that hides neonates, cows without neonates being more visible or low pregnancy rates is not known. We have had recent discussions in the region about embarking on efforts to better understand the Units 17B and 17C moose population which would include radiocollaring a sample of female moose in the near future to help understand moose movement patterns, calving timing, productivity, survival and other population parameters. These pieces of data would provide an important foundation in understanding this moose population.

Recommendations for Activity 1.2.

Continue.

2. Mortality-Harvest Monitoring and Regulations

ACTIVITY 2.1. Monitor and analyze harvest and other mortality annually.

Data Needs

Monitoring and analyzing harvest data are essential to determine whether the IM harvest objectives have been achieved and to provide insight into whether harvests are sustainable. These data are often the core of information presented and discussed during our regulatory processes and are always an important component in guiding our management decisions. Harvest and effort data provide valuable insight into game abundance and whether the present seasons and bag limits are sustainable. Unreliable harvest and effort information that biologists cannot trust, takes away this very important management tool. Unfortunately, the compliance to harvest reporting in Unit 17 does not appear to be very good. When comparing subsistence household survey data for moose harvest with that reported on moose permits and harvest tickets the differences are startling. In some villages the household surveys indicate a 100% increase over harvest reports (Holen et al. 2005; Krieg et al. 2009; Holen et al. 2012; Evans et al. 2013). Working with communities in Unit 17 to improve harvest reporting is an essential element of a successful management program.

Methods

We collected harvest data by means of general season harvest ticket reports (GM000), registration permit reports (RM573, RM575, RM576, RM583, RM585, RM587), and a single draw permit report (DM570). These data were compiled in the ADF&G Wildlife Information Network's (WinfoNet) moose harvest database. To encourage hunters to report their hunting effort, we used the local radio station and newspaper to prompt hunters to report. We also met face to face with many of the permittees during the permitting issuance and stressed the need to comply with reporting requirements. Hunters who did not report on their permits were then sent reminder letters and eventually put on the failure to report list if they failed to comply with the permit reporting requirements. We monitored harvest and cooperated with enforcement efforts of the Alaska Wildlife Troopers during the hunting season.

We reviewed household survey reports when available to assess likelihood of additional harvest not always reported above (Holen et al. 2005; Evans et al. 2013).

Results and Discussion

Season and Bag Limit

Current Unit 17 moose season dates and bag limits are available on the ADF&G website:

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

The majority of the moose hunting effort in Unit 17 is conducted through registration permit hunts. The fall seasons vary slightly across the unit; Unit 17A resident season 25 August–20 September and Units 17B and 17C season 20 August–15 September. Both of these permit hunts allow the harvest of any bull, and neither are limited in the number of permits allowed. In Unit 17B, nonresident hunters can hunt portions of the of the Mulchatna and Nushagak River corridors by registration permit, with a season of 5–15 September, and a selective harvest strategy for bull moose of 4 brow tines or ≥50-inch antlers. Units 17B and 17C also have a general season for resident hunters of 1–15 September, but that includes a selective bull harvest criteria of spike-fork, 3 brow tines or ≥50-inch antlers. There is also a fall draw hunt in Unit 17A for nonresidents that we allow 20 permits during 5–15 September, with a selective harvest of 4 brow tines or ≥50-inch antlers.

There are also winter hunts in all units. In Unit 17A, the winter hunt is for either sex, with a bag limit of 2 moose. The season is restricted to 30 days within the dates of 1 December to the end of February, with harvest quotas of 10 cows and 15 bulls. In Units 17B and 17C the winter hunts are 1–31 December with a bag limit of 1 antlered bull, but no quotas on total harvest.

Harvest by Hunters

Reported harvest of moose has been below the IM objective for Unit 17B (200–400) since RY00, with a significant downward trend over time. In Unit 17C the IM objective for harvest (165–350) was met throughout RY00–RY12, but not during either of the past 2 regulatory years. Harvest in Unit 17A has slowly been increasing over time and we expect this population to provide more opportunity for harvest in future years (Table 2). Harvest across Unit 17 as a whole was within the amount reasonably necessary for subsistence range of 100–150.

Hunters continued to harvest moose with large antlers throughout this reporting period. During RY10–RY14, at least 44% of the moose antler dimensions that were recorded on hunt reports consisted of moose with antler spreads of 50 inches or greater. The largest antlers reported for each season of this reporting period has been at least 69 inches with RY14 being 80 inches (Table 3).

Table 3. Unit 17 moose antler sizes (percent) in the harvest, Southwest Alaska, regulatory years[a] 2010–2014.

Regulatory year	Antler size[b] (%) <30″	30–50″	>50″	Largest antlers (inches)
2010	5	38	57	70″
2011	15	39	46	69″
2012	12	44	44	72″
2013	16	37	47	75″
2014	10	46	44	80″

[a] A regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] This represents only those antler measurements provided by hunters, which is only a portion of the total.

Unreported harvest in these units is unknown but could be fairly significant. This is especially true during the winter hunts across the unit where we have reason to believe the actual harvest is substantially higher than what is reported. This belief is based on learning of illegal and unreported kills through investigations with the Alaska Department of Public Safety.

Permit Hunts, Hunter Residency and Success, Harvest Chronology, Transport Methods

General harvest information for specific hunt types (general season, registration, drawing) harvest history, hunt area harvest, transportation methods used, harvest by residency, and seasonality of harvest are available to the public for hunt planning on the ADF&G website: https://secure.wildlife.alaska.gov/index.cfm?adfg=harvest.main.

<u>General Hunt</u>

The general moose hunt in Units 17B and 17C is shorter and has a more restrictive bag limit than the registration hunt. Greater numbers of nonlocal Alaska residents and nonresidents hunt moose during this hunt than local (Unit 17) Alaska residents (Table 4). This is because local residents take advantage of the registration permit hunt (RM583) that is less restrictive and has an earlier starting date than the general season hunt. Unit 17A has not had a general moose hunting season since RY80. The reported harvest during the 5 years of this reporting period for the general moose season in Unit 17B ranged from 17 to 37, with a mean annual harvest of 27 moose (Table 5). In Unit 17C, the 5-year mean annual harvest for the general hunt was 12 moose, with a range of 7–17 (Table 6). The higher general season harvest in Unit 17B versus Unit 17C is largely due to the nonresident hunters who can participate in moose hunting in Unit 17B, but not in Unit 17C.

Table 4. Units 17B and 17C general season moose hunter residency and success, Southwest Alaska, regulatory years[a] 2010–2014.

	Successful				Unsuccessful				
Regulatory year	Local resident (%)	Nonlocal resident (%)	Nonresident (%)	Total (%)	Local resident	Nonlocal resident	Nonresident	Total (%)	Total hunters
2010	3 (9)	15 (23)	29 (45)	47 (29)	29	49	36	114 (71)	161
2011	5 (13)	9 (21)	14 (44)	28 (25)	33	34	18	85 (75)[b]	113
2012	6 (15)	18 (25)	16 (28)	40 (24)	34	53	42	129 (76)[c]	169
2013	6 (17)	10 (22)	17 (35)	33 (25)	30	35	32	97 (75)	130
2014	5 (14)	18 (29)	22 (34)	45 (27)	32	44	43	119 (73)	164

[a] A regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Does not include 4 unsuccessful and 2 successful hunters of unknown residency.
[c] Does not include 1 successful hunter of unknown residency.

Table 5. Unit 17B general season reported moose harvest, Southwest Alaska, regulatory years[a] 2010–2014.

Regulatory	Reported harvest			
year	M (%)	F (%)	Unk	Total
2010	37 (100)	0 (0)	0	37
2011	17 (100)	0 (0)	0	17
2012	27 (100)	0 (0)	1	28
2013	24 (100)	0 (0)	0	24
2014	29 (100)	0 (0)	0	29

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

Table 6. Unit 17C general season reported moose harvest, Southwest Alaska, regulatory years[a] 2010–2014.

Regulatory	Reported harvest			
year	M (%)	F (%)	Unk	Total
2010	9 (100)	0 (0)	0	9
2011	13 (100)	0 (0)	0	13
2012	13 (100)	0 (0)	0	13
2013	7 (100)	0 (0)	0	7
2014	17 (100)	0 (0)	0	17

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

Permit Hunts

Longer seasons and more liberal bag limits have enticed many resident hunters to participate in the registration permit hunts across Unit 17 (RM573, RM575, RM576, RM583, and RM585). Tables 7, 8, 9, and 10 portray the progression of permit hunt information across Unit 17. The level of participation has been on an increasing trend over the past 20 years (Barten 2014). Unit 17A in particular has gained more hunters and hunting opportunity with the recently created antlerless hunt in 2013 (RM575), the implementation of a 2 moose bag limit, and the addition of the nonresident draw hunt (DM570) in 2014. When looking at tables 7–10, it is important to note that in most of the registration permit hunts, the same hunters might get permits for all the hunts in their area. For instance, a hunter from Dillingham would likely get a permit for RM583 and RM585, while one from Togiak would likely get a permit for RM573, RM575, and RM576. The data as presented in the tables that tally the number of permittees and number of hunters may be counting a single individual 1–3 times depending on how many of the permits they acquire. The winter hunts are becoming increasingly popular across the unit, and what used to be looked at as an additional opportunity for a few hunters who failed to get a moose in the fall, has developed into "a whole new season" approach for many hunters. Although Unit 17A appears to have a growing moose population that can handle the additional winter hunt pressure, the remainder of the unit with decreasing bull harvest and no demographic data associated with bull:cow ratios may not be able to absorb this additional harvest without negatively affecting the demographic structure of the population.

Table 7. Unit 17 moose hunter residency and success for permit hunts, Southwest Alaska, regulatory years[a] 2010–2014.

	Successful									Unsuccessful					
Regulatory year	Local[c] resident	(%)	Nonlocal resident	(%)	Nonresident	(%)	Total	(%)	Local[b] resident	Nonlocal resident	Nonresident	Total	(%)	Total hunters[b]
2010	248	(25)	40	(43)	9	(25)	297	(26)	751	53	27	831	(74)	1,128
2011	268	(27)	36	(33)	13	(37)	317	(28)	735	73	22	830	(72)	1,147
2012	214	(22)	35	(32)	12	(33)	261	(24)	742	74	24	840	(76)	1,101
2013	183	(19)	23	(24)	9	(25)	215	(20)	783	73	27	883	(80)	1,098
2014	217	(22)	17	(20)	10	(32)	244	(23)	749	67	21	837	(77)	1,081

[a] A regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] Does not include hunters of unknown residency.
[c] Hunters whose community of residence lies within Unit 17.

Table 8. Unit 17A reported moose harvest data by permit hunts, Southwest Alaska, regulatory years[a] 2010–2014.

Hunt no./area	Regulatory year	Permits issued[b]	Number hunters afield	Number successful hunters	Percent successful hunters	Bulls	(%)	Cows (%)	Unk	Total harvest
RM573	2010	145	125	37	30	36	(97)	1	0	37
RM575	2011	181	159	50	31	47	(94)	0	3	50
RM576	2012	212	160	46	29	44	(96)	0	2	46
DM570	2013	300	205	36	18	27	(75)	7	2	36
	2014	290	217	57	26	44	(77)	12	1	57

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

Table 9. Unit 17B reported moose harvest data by permit hunts, Southwest Alaska, regulatory years[a] 2010–2014.

Hunt no./area	Regulatory year	Permits issued[b]	Number hunters afield	Number successful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
RM583	2010	1,203	209	55	26	55 (100)	0	0	55
RM587	2011	1,285	180	46	26	45 (98)	0	1	46
RM585	2012	1,209	153	28	18	27 (96)	0	1	28
	2013	1,498	165	39	24	39 (100)	0	0	39
	2014	1,458	122	33	27	33 (100)	0	0	33

[a] A regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] RM583 and RM585 registration permits valid for both Units 17B and 17C. Permit data are for both areas combined; hunters and harvest data are specific to Unit 17B.

Table 10. Unit 17C reported moose harvest data by permit hunts, Southwest Alaska, regulatory years[a] 2010–2014.

Hunt no./area	Regulatory year	Permits issued[b]	Number hunters afield	Number successful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
RM583	2010	1,204	766	194	25	193 (99)	0 (0)	1	194
RM585	2011	1,285	821	223	27	221 (99)	0 (0)	2	223
	2012	1,209	794	186	23	183 (98)	0 (0)	3	186
	2013	1,459	683	143	21	143 (100)	0 (0)	0	143
	2014	1,425	558	147	26	146 (99)	0 (0)	1	147

[a] A regulatory year begins 1 July and ends 30 June (e.g., regulatory year 2010 = 1 July 2010–30 June 2011).
[b] RM583 and RM585 registration permits valid for both Units 17B and 17C. Permit data are for both areas combined; hunters and harvest data are specific to Unit 17C.

Hunter Residency and Success

Although the overall number of resident hunters participating in moose hunts in Unit 17 is on an increasing trend, the nonresident component of hunters has been staying steady at a low level over the past 10 years for permit hunts and has declined dramatically under the general hunt since the mid-2000s (Barten 2014). The nonresident participation has been impacted mostly by 2 factors: 1) in 2005 the corridor of the Nushagak and Mulchatna rivers went from a general season hunt to a limited registration permit hunt (75 permits allowed by regulation), and 2) the nonresident hunt for Mulchatna caribou was closed in 2009 which took away a huge incentive for nonresident hunters to conduct a combination hunt for moose and caribou. Both nonresident hunters and nonlocal resident hunters generally have a higher success rate for moose hunting than local hunters (Tables 4 and 7). This is a result of the local hunters generally competing against each other for moose along the major river corridors or lakes within reach of their villages, or accessible via the Dillingham road system. Nonlocals and nonresidents on the other hand generally fly out to destinations that contain good moose habitat but where competition for moose is much lower.

Other Mortality

Observations of predation of moose by wolves and bears occurred on occasion during this reporting period. Reports from local residents suggest wolf numbers have been increasing unitwide, and brown bears are common. Snow depths throughout the unit were moderate during the past 3 winters which should have benefitted moose, with less energy expended for locomotion, more habitats and therefore forage available and less vulnerability to wolf predation.

Illegal harvest of moose in Unit 17 may be a significant factor toward the overall mortality. This seems especially true during the winter hunt when hunters can disperse across the landscape and access moose in many of the otherwise inaccessible areas. Evidence from the local winter hunt in the area of Land Otter Creek in Unit 17C indicates that several cow moose have been harvested during the winter bull hunt (J. D. Wittcop, Wildlife Trooper, Alaska Department of Public Safety, Dillingham, personal communication).

Alaska Board of Game Actions and Emergency Orders

BOG addressed 2 proposals to liberalize moose hunting opportunity in Unit 17; both were specific to Unit 17A. These included the adoption of an antlerless hunt during the winter season, and the adoption of a nonresident draw hunt with antler restrictions for bull moose. Both of these regulatory changes were made in lieu of objectives identified within the Unit 17A moose management plan. Stakeholders agreed that the moose population at a certain level could accommodate additional opportunity, and the department submitted proposals to BOG to make this happen.

BOG summary information is available on the ADF&G website:

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

Emergency orders were issued by the department to manage registration hunts during the reporting period. In Unit 17A, emergency orders were issued each year to open the RM575 moose hunt, and beginning in RY13, the newly adopted RM576 hunt was also opened by emergency order. Additionally, emergency orders were used to extend the moose seasons in Unit 17A on several occasions. These season extensions were accommodated because poor snow conditions during the scheduled season prevented hunters from accessing moose.

Recommendations for Activity 2.1.

Continue.

3. Habitat Assessment-Enhancement

ACTIVITY 3.1. Assess habitat condition.

Data Needs

We have no reason to believe habitat is limiting moose in Unit 17, but a greater understanding of moose forages and how they might affect moose fitness would add to our overall understanding of moose ecology in Unit 17.

Methods

Dr. William Collins, a Wildlife Physiologist with ADF&G out of the Palmer office has been conducting moose browse studies in Unit 17 over the past 3–4 years, in cooperation with Andy Aderman (Wildlife Biologist) with the Togiak National Wildlife Refuge. The objective of these browse studies is to determine forage quality, relative to other moose ranges that have been sampled around the state. Dr. Collins is particularly interested in the significance of tannin in the western Alaska ecosystem. Initially the study focused entirely on the Togiak National Wildlife Refuge, then expanded to include the lower Nushagak and the Goodnews drainages to see if tannin levels are lowest in the ranges historically utilized the least amount of time by moose. Partway through this effort, a major outbreak of insect defoliation occurred, and the objectives of the study expanded to include defoliated shrubs, and whether defoliated plants produced more or less tannin than foliated shrubs (Dr. William Collins, Wildlife Physiologist, ADF&G, Palmer, personal communication). No data associated with this study are available at this time.

Results and Discussion

The data being collected on moose habitat conditions in Unit 17 will provide valuable insight into forage quality as it affects moose on a local level as well as context on a broader statewide level.

Recommendations for Activity 3.1.

Continue.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Harvest Reporting Acceptance

Moose management in Unit 17 relies heavily on harvest data to provide insight into the sustainability of the present seasons and bag limits. In Unit 17A we have harvest quotas for antlered and antlerless moose, and use emergency orders to close the moose seasons when these thresholds are met. In Units 17B and 17C, we do not have quotas for our moose harvest, but rather, believe the moose population can sustain the seasons and bag limits we have in place and still remain healthy. Throughout this unit then, the reported harvest of moose is an important piece of information, yet one that appears to be unreliable.

Moose Survey Conditions

The weather in Bristol Bay is always challenging for conducting moose surveys. The maritime climate leads to many freeze-thaw cycles during an average winter that leave only short windows where adequate snowfall can be utilized for aerial surveys before the next warm spell melts the snow. That and extreme wind conditions make this a very challenging and not ideal location for aerial surveys during any time of year. With the recent climactic warming trend, it has become even more challenging to get adequate snow cover to conduct surveys, leaving biologists without up to date abundance estimates, and estimates that provide confidence in understanding the moose population trends.

Data Recording and Archiving

- GSPE and harvest data are stored on an internal database housed on a server (http://winfonet.alaska.gov/index.cfm).
- All other electronic data and files such as survey forms, survey memos, and reports are on the computer (H:\WILDLIFE\DWC-Neil\Moose) in the Dillingham Area Biologist office. This is a network drive that is backed up daily.
- Hard copies of surveys, memos, etc. are stored in file cabinets in the Dillingham Area Biologist office, located in the Dillingham Fish and Game office.

Agreements

- Moose Management Plan for Game Management Unit 17A, (Unit 17A Moose Management Group 2013).
- Cooperative Agreement F16AC00365: Adapting to a warming climate: Estimating moose abundance in declining snow cover (Appendix C).

Conclusions and Management Recommendations

Based on the most recent aerial surveys conducted in Unit 17, the moose populations appear to be stable or increasing. In Unit 17A, moose have only recently colonized some areas of this unit, and based on productivity data from current studies (Aderman 2014), moose numbers are likely still on the rise. Unit 17B moose abundance appears to be stable, while the most recent survey in Unit 17C yielded a significant increase in moose numbers from the past survey. The moose harvest in Units 17B and 17C however indicates something else is going on that is responsible for a steady decline over the past 12 years. Moose are apparently less available based on reported harvest; whether this is related to the number of bulls on the landscape, a change in moose behavior, or possibly tactics used by hunters that are less successful than in the past needs to be further explored. Certainly, the past few years with warmer weather in the fall seems to have some effect on the moose activity levels especially related to the rut. With bulls being less active and less likely to respond to calls, hunters would be less successful, and more than a few hunters think this is a major factor in declining fall harvest. Many locals including air charter operators suggest moose numbers are much lower than they were in the early 2000s when harvest levels peaked in Unit 17 and they blame the extreme heavy-snow winters in the past decade for leading to high moose mortality. This mortality came in the form of moose expiring during the difficult winter due to high energetic demands associated with travelling in deep snow as well as their inability to easily get to and access forage. Being in a weakened state also made them more vulnerable to predation, especially by bears during the spring of the year. I think one factor that could be important here is harvest reporting and the likelihood that far more moose are being taken than reported on the harvest reports. Whether this has changed over time to suddenly be an important factor is unknown.

Given the importance of moose to local and nonlocal hunters in this unit, it is important for the department to do what they can to better understand these moose populations. In Unit 17A, the USFWS-TNWR has done a great job of collecting data over the past 25 years providing excellent insight into moose productivity, survival, and population dynamics. This type of data would be extremely valuable in Units 17B and 17C where moose hunting and the subsistence use of moose is much higher than in Unit 17A. Throughout Alaska, moose managers use bull to cow ratios as a major source of information in guiding their hunt management. This important piece of information is lacking here in Unit 17. With a declining harvest that is below IM objectives in Unit 17B, this basic information should be the first step toward a better understanding of the moose population and of moose management in this unit. I recommend that efforts should be invested in designing and implementing surveys to gather moose demographic data.

II. Project Review and Plan

Review of Management Direction

MANAGEMENT DIRECTION

There are no changes in the management direction for moose in Unit 17.

Moose management in Unit 17A has been active and adaptive thanks to cooperative data collection strategies between TNWR and ADF&G. These data have been instrumental in guiding a Unit 17A moose management plan, which in turn has led to an adaptive management approach to a moose management strategy that includes implementation of an antlerless hunt, a nonresident draw hunt, and lengthening the winter season to allow for an increase in harvest opportunity. These measures along with 25 years of moose research in Unit 17A have yielded a very robust data-driven management strategy. In addition to the above measures, the department is presently a cooperator with TNWR in conducting a study to determine moose sightability under poor snow conditions in Units 17A and 18 – to allow for annual population surveys even in years with little to no snow.

Unlike Unit 17A, the understanding of moose ecology in Units 17B and 17C has been limited to survey and inventory activities in the form of occasional abundance estimates. Up until 2003, the moose harvest in these 2 units was on an increasing trend. However, since then, there has been a steady and dramatic decline in harvest. Although we have been able to acquire abundance data every 3–4 years in each of these units, the timing of our surveys precludes the ability to determine moose demographics. With the declining bull harvest and very liberal seasons for moose in these units, acquiring demographic data is essential to determining if our present harvests and hunting seasons are sustainable.

Goals

- Develop methodology for assessing bull:cow ratios.
- Initiate study to assess moose productivity and recruitment.
- Improve moose harvest reporting and compliance with hunting regulations.
- Determine moose population size, trend, and composition.
- Maintain healthy age and sex structures within Unit 17 moose populations.
- Provide for maximum opportunity to participate in hunting moose.
- Provide for consumptive and nonconsumptive uses of moose populations.

Codified Objectives

Amounts Reasonably Necessary for Subsistence Harvest

The Unit 17 moose population has a positive customary and traditional use determination finding. The unitwide amount reasonably necessary for subsistence is 100–150 moose.

Intensive Management

In 2001 BOG adopted a positive finding for IM of moose in Units 17B and 17C (no positive finding in Unit 17A). Current IM objectives are as follows:

- Population objectives:
  - Unit 17B: 4,900–6,000
  - Unit 17C: 2,800–3,500
- Harvest objectives:
  - Unit 17B: 200–400
  - Unit 17C: 165–350

Review of Management Objectives

There are no suggested changes to the management objectives.

Unit 17A

- Provide for a minimum population of 300 moose and manage for a target population of 1,100–1,750 moose.

Unit 17B

- Manage for a population of 4,900–6,000 moose with a human use objective of 200–400 moose. Achieve and maintain a density of 1 moose/mi^2 on habitat considered good moose range.

Unit 17C

- Manage for a population of 2,800–3,500 moose with a human use objective of 165–350 moose. Maintain a minimum density of 0.5 moose/mi^2.

All Subunits

- Design strategy for collecting demographic data on moose populations, in particular bull:cow ratios.

REVIEW OF MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Conduct aerial surveys to estimate moose abundance, composition, productivity, and trends in these indices.

Data Needs

With the recent transition from the Gasaway surveys to the GSPE methodology we would continue to use GSPE surveys to estimate moose abundance in each of the following areas: Units 17B-west, 17B-east, 17C, and 17A. We plan to conduct a survey in each of these areas on a triennial basis weather permitting. There are, however, important considerations as we move forward with abundance surveys:

- Some thought should go into defining the level of precision we are seeking, and this should be incorporated into GSPE survey expectations.
- Because snow conditions dictate success of these winter surveys, we should strive to better understand snow accumulation patterns and consider using that information to adjust survey boundaries and take advantage of snow where available. We might have to be content with completing surveys in smaller portions of the overall unit and using these estimates similar to how trend surveys were used in the past.
- With the short weather windows in Bristol Bay, any habitat use data we can collect from moose using radio collars that would inform a desktop stratification would save several days of potentially good weather for conducting the actual survey.

ACTIVITY 1.2. Spring twinning surveys.

Data Needs

No change from previous reporting period.

Methods

After conducting twinning surveys the past 2 springs (RY14 and RY15), we have a better understanding of what it takes logistically to be successful with this effort. At this point, I would recommend involving research and biometric support staff to design a twinning survey strategy for Unit 17C and possibly Unit 17B.

ACTIVITY 1.3. Fall composition surveys.

Data Needs

This is a new activity that has been added due to the importance of composition data. Moose surveys in Unit 17 have traditionally been conducted February–March due to lack of snow cover during the more traditional November period that is used in many other parts of the state. Because of the late timing of the surveys in Unit 17, antler drop has already occurred, preventing biologists from obtaining bull:cow ratio data. With the declining bull harvest in Units 17B and 17C over the past 10 years, and the liberal hunting seasons that include a winter hunt, we need to acquire this demographic information to assess the sustainability of our present season and harvest.

Methods

Although the typical post-rut period in Bristol Bay seldom provides snow cover for traditional composition surveys, we will evaluate the efficacy of conducting trend surveys in areas where moose traditionally congregate post rut, with or without snow. These areas would have to be defined through reconnaissance surveys in the first year, but future years should get easier. With much of the area adjacent to the major watersheds transitioning into tundra, recon surveys could focus on the watersheds which are fairly linear and could be surveyed in a systematic fashion. The concern with these surveys in forested habitat would be the likelihood of missing animals peripheral to the focal animals, which could skew the results of the survey.

Another methodology that is available and used in a few select areas of the state for obtaining bull:cow ratio data even after antler drop is employing a helicopter and determining sex of moose based on a suite of morphometric features. The most reliable and obvious would be presence of antlers, followed by the presence of a vulva patch in females, color of the face, size of moose in relation to adjacent animals, shape of the bell, and behavior.

Study design for collecting composition data using a helicopter would be derived with the help of research and biometric support staff.

2. Mortality-Harvest Monitoring

ACTIVITY 2.1. Increase participation in harvest reporting.

Data Needs

Better data on hunter effort and harvest.

Methods

Work with local communities to instill the core values of being responsible hunters by reporting harvest and effort in a timely manner.

Consideration should be given to acquiring an ADF&G Facebook page in rural communities for outreach to hunters.

<u>3. Habitat Assessment-Enhancement</u>

ACTIVITY 3.1. Use browse surveys to determine species composition and utilization by moose.

No change from previous reporting period.

Methods

No habitat assessment activities are planned for the next reporting period. However, if after several years of twinning surveys we detect lower rates than would be expected, browse utilization surveys could be considered.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Continue to work with the stakeholders associated with the Moose Management Plan for Game Management Unit 17A (Unit 17A Moose Management Group 2013).

<u>Data Recording and Archiving</u>

Paper records such as aerial survey forms, twinning forms, and telemetry data sheets are scanned and stored electronically on the area biologist's personal network drive (H:) and are stored as hard copies in file cabinets in the area biologist's office. Backup of H: drive occurs daily. All other electronic or digital files are stored in the H: drive as well.

<u>Agreements</u>

- Moose Management Plan for Game Management Unit 17A (Unit 17A Moose Management Group 2013).
- Cooperative Agreement F16AC00365: Adapting to a warming climate: Estimating moose abundance in declining snow cover (Appendix C).

References

Aderman, A. R. 2014. Monitoring moose demographics at Togiak National Wildlife Refuge, southwestern Alaska, 1998–2013. Togiak National Wildlife Refuge and Alaska Department of Fish and Game, Dillingham, Alaska.

Barten, N. L. 2014. Unit 17 moose. Chapter 19, Pages 19-1 through 19-24 [*In*] P. Harper and L. A. McCarthy, editors. Moose management report of survey and inventory activities 1 July 2011–30 June 2013. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2014-6, Juneau.

DeLong RA. 2006. Geospatial population estimator software user's guide. Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks.

Evans, S., M. Kukkonen, D. Holen, and D. S. Koster. 2013. Harvests and uses of wild resources in Dillingham, Alaska, 2010. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 375, Anchorage.

Faro, J. B. 1973. Unit 17 moose. Pages 117–119 [*In*] D. E. McKnight, editor. Annual report of survey-inventory activities, 1971. Part I. Moose, Deer, and Elk. Alaska Department of Fish and Game, Division of Game, Federal Aid in Wildlife Restoration Jobs 1, 2, and 13, Juneau.

Gasaway, W. C., S. D. DuBois, D. J. Reed, and S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Institute of Arctic Biology, Biological Papers of the University of Alaska, No. 22, Fairbanks.

Holen, D., J. Stariwat, T. M. Krieg, and T. Lemons. 2012. Subsistence harvests and uses of wild resources in Aleknagik, Clark's Point, and Manokotak, Alaska, 2008. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 368, Anchorage.

Holen, D. L., T. Krieg, R. Walker, and H. Nicholson. 2005. Harvests and uses of caribou, moose, bears, and Dall sheep by communities of Game Management Units 9B and 17, western Bristol Bay, Alaska 2001–2002. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 283, Juneau.

Krieg, T. M., D. L. Holen, and D. Koster. 2009. Subsistence harvests and uses of wild resources in Igiugig, Kokhanok, Koliganek, Levelock, and New Stuyahok, Alaska, 2005. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 322, Dillingham.

Oswald, K. 1997. Moose aerial observation manual. Ontario Ministry of Natural Resources, Northeast Science & Technology, Canada.

Reed, D. J. 1989. MOOSEPOP: Program documentation and instruction. Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks.

Taylor, K. P. 1990. Unit 17 moose. Pages 177–185 [*In*] S. O. Morgan, editor. Annual report of survey-inventory activities 1 July 1988–30 June 1989. Alaska Department of Fish and Game, Division of Wildlife Conservation, Federal Aid in Wildlife Restoration Study 1.0, Juneau.

Unit 17A Moose Management Group. 2013. Moose management plan for Game Management Unit 17A. Alaska Department of Fish and Game, Division of Wildlife Conservation, Dillingham.

Van Daele, L. J. 1995. Mulchatna caribou. Pages 22–37 [*In*] M. V. Hicks, editor. Management report of survey-inventory activities 1 July 1992–30 June 1994. Alaska Department of Fish and Game, Division of Wildlife Conservation, Federal Aid in Wildlife Restoration Study 3.0, Juneau.

Woolington, J. D. 2012. Unit 17 moose. Pages 245–269 [*In*] P. Harper, editor. Moose management report of survey-inventory activities 1 July 2009–30 June 2011. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2012-5, Juneau.

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Appendix A. Moose management plan for Game Management Unit 17A, Southwest Alaska, 8 January 2013.

January 8, 2013

MOOSE MANAGEMENT PLAN
for
GAME MANAGEMENT UNIT 17A

INTRODUCTION

Since creation of the Togiak National Wildlife Refuge in 1980, moose numbers and harvest opportunities have changed dramatically, especially within Game Management Subunit (Unit) 17A. While moose have occurred in the Togiak and Kulukak drainages since before Statehood, their numbers were few and harvest pressure was high. This trend continued throughout the 1980's despite a closure to moose hunting implemented in 1981. During the same time, numbers were increasing in the Nushagak Bay drainages (Unit 17C) to the east providing a source for moose emigrating west. In 1995, a cooperative survey with the Alaska Department of Fish and Game (ADF&G) estimated 136 moose in Unit 17A. From this initial survey in 1995 until 2011, the population has been closely monitored through eight subsequent population estimates which have revealed a progressive and substantial increase in moose numbers. The most recent estimate, conducted in March 2011, indicated a minimum population of 1,166.

Probable reasons for the moose population increase in Unit 17A include: 1) continued immigration from neighboring Unit 17C; 2) regulation changes implemented by the Alaska Board of Game; 3) cooperation and commitment by local Unit 17 residents in helping the moose population to grow; 4) availability of Mulchatna caribou in Units 17 and 18; and 5) good productivity and recruitment of moose in Unit 17A due to abundant forage, mild winters, and relatively low predation rates.

Coincident with the increasing Unit 17A moose population, a group of entities interested in the management of this moose population was formed (the Unit 17A Moose Management Group), consisting of the Bristol Bay Federal Subsistence Regional Advisory Council, the Nushagak and Togiak Fish and Game Advisory Committees, the Togiak National Wildlife Refuge, and the Alaska Department of Fish and Game GMU 17 management office. The Group drafted several versions of a Unit 17A Moose Management Plan from 1996 to 2004. The February 23, 2004 draft plan has been used as a guide in monitoring and managing moose in this area.

During the years 1996-2004, several regulatory requests to open/change hunting seasons were proposed. Fall hunting for bulls was reinstated in 1997. When the population exceeded 600 moose, a winter hunt for antlered bulls was approved for 2002-03. Preliminary habitat surveys in the late 1990's estimated a carrying capacity of 1,100 to 1,750 moose for Unit 17A, and these estimates served as the basis for the original version of this plan. However, refinement of the estimate of moose winter habitat based on a revised habitat map indicates a carrying capacity of 900 to 1,350 moose may be more realistic. Thus, this updated plan incorporates changes to the 2004 plan based on the refined carrying capacity estimate and moose demographic and harvest monitoring through 2012.

The Moose Management Plan (Plan) is intended to guide future regulatory proposals and decisions regarding moose in Unit 17A. Cooperation among Plan participants and area residents is critical to the success of this Plan.

PRINCIPLES

The Plan acknowledges the need for coordinated management consistent with State and Federal laws and regulations, and traditional lifestyle of area residents. Principles agreed upon by all parties concerning Unit 17A moose include:

1. Moose are an important subsistence resource for area residents.

2. The users and management agencies want moose to expand their range and increase in numbers consistent with available habitat.

3. Moose reproductive and physical measures and estimates of carrying capacity will be used when setting population level goals to ensure protection of the vegetation resource.

4. Effective management of Unit 17A moose is a high priority to insure a sustainable level of harvest as well as providing a subsistence priority on State and Federal lands.

5. Cooperation and participation between Plan participants is essential to achieve the goals and objectives of this Plan.

6. The management planning process is ongoing. Updating and improving the Plan will increase its effectiveness.

7. Continued monitoring of the size, production, movements, distribution and habitat of Unit 17A moose is essential to the success of the Plan.

8. The Plan should be integrated with other management programs.

MOOSE MANAGEMENT GOALS AND OBJECTIVES

Management goals of this plan explain what is planned for the management of moose in Unit 17A. Management objectives describe how the goals can be carried out.

Goal 1: Ensure a self-sustaining moose population in Unit 17A.

<u>Management Objectives for Goal 1</u>

1. Maintain the Unit 17A moose population at 800 to 1,200 moose. This population range may be adjusted based on moose reproductive and physical parameters.

2. Monitor moose population parameters through aerial radio-tracking surveys, and a population estimate conducted every two years or as needed.

3. Maintain a minimum of 20 radio-collared moose to monitor calf production, survival and recruitment, movements and adult mortality.

4. Maintain a close working relationship among Plan participants in managing this moose population.

5. Consider and implement other research as necessary.

Goal 2: Maintain and protect moose habitat and other necessary components of the ecosystem in Unit 17A upon which the moose population depends.

<u>Management Objectives for Goal 2</u>

1. Continue to describe, quantify, and map existing vegetation cover types.

2. Ensure the Unit 17A moose population does not exceed carrying capacity.

3. Determine nutritional qualities of moose browse.

4. Work with village corporations and private landowners to minimize the impacts to moose habitat in Unit 17A.

Goal 3: Provide for a regulated harvest in a manner consistent with Federal and State laws, and the goals and objectives of this management plan.

<u>Management Objectives for Goal 3</u>

1. When the population is less than 300 moose, no harvest will occur.

2. When the population trend is stable or increasing above 300 moose, allow a fall and winter harvest of bulls, by State registration permit available in Togiak and Dillingham. If the population trend is declining and is between 300 – 600 moose, harvest may be reduced or suspended.

3. When the population trend is stable or increasing and above 600 moose, allow a limited winter hunt for antlerless moose. When the population trend is declining and is between 600 and 900 moose, the antlerless harvest may be suspended.

4. Aircraft access will be restricted for the fall hunt for two miles either side of the Togiak River, Togiak Lake, Izavieknik River, Upper Togiak Lake (Second Lake), Ongivinuck River and along the lower five miles of both the Kemuk (also known as Narogurum) and Nayorurun (also known as Nagugun or Kashaiak) Rivers (Figure 1).

5. When the population trend is stable or increasing and exceeds 1,000 moose, allow a limited fall nonresident hunt by State permit. When the population exceeds 1,000 but shows a declining trend, nonresident hunting will be suspended. Permits will be phased in with up to 5 permits issued in the first year and up to 10 permits issued in the second year of non-resident hunting. After the second year, up to 5 permits will be available when the population is between 1000 and 1100, up to 10 permits will be available when the population is between 1100 and 1200, and up to 20 permits when the population exceeds 1200.

6. Hunting regulation proposals and recommendations, consistent with this management plan, will be developed cooperatively with Plan participants and submitted to the Federal Subsistence Board and Alaska Board of Game.

Goal 4: Encourage cooperative management and communication between Plan participants in developing and carrying out management, research and enforcement programs, and with the public by exchanging ideas and knowledge about Unit 17A moose.

<u>Management Objectives for Goal 4</u>

1. Plan participants will meet as needed to update the plan and discuss issues involving moose in Unit 17A.

2. Plan participants will cooperate in formulating and reviewing management and research programs including but not limited to an aerial census, aerial surveys, radio telemetry monitoring, composition counts, recruitment surveys and harvest reporting.

3. Plan participants will coordinate to the extent possible enforcement activities that are to be conducted within Unit 17A or adjacent areas.

4. Plan participants will provide information to local residents and conduct public programs concerning the importance of managing the moose population. In addition both agencies plan to provide information and educational materials concerning moose ecology, subsistence use and stress the significance of the cooperative moose management plan. Plan participants will work closely with area residents to ensure there are opportunities to discuss management activities and concerns people may have.

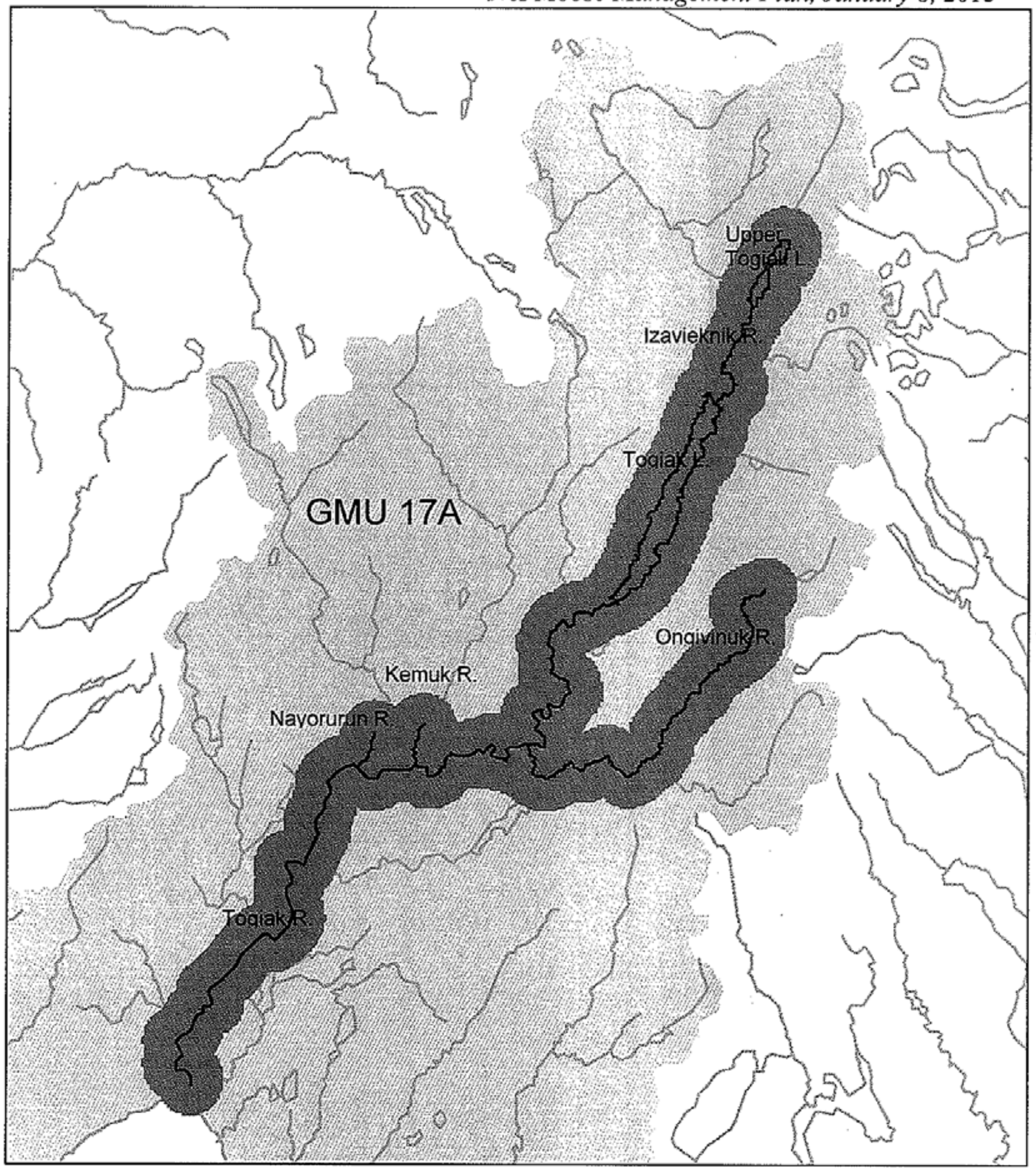

Figure 1. Central portion of GMU 17A, showing aircraft restricted area extending 2 miles to either side of Togiak, Nayorurun, Kemuk, Ongivinuk, and Izavieknik Rivers and Togiak and Upper Togiak Lakes.

SIGNATURES

By their signatures below, the undersigned hereby certify their participation in and agreement with the Moose Management Plan for Game Management Unit 17A.

SOF — 1/8/13

Togiak Advisory Committee, Chairman — Date

SOF — 1/8/13

Nushagak Advisory Committee, Chairman — Date

Bristol Bay Regional Advisory Council, Chair — Date

SOF — 1/8/2013

Togiak National Wildlife Refuge, ACTING Refuge Manager — Date

SOF — 1/8/2013

Alaska Department of Fish & Game, Area Biologist — Date

Appendix B. Unit 17C moose twinning survey, Southwest Alaska, June 2015.

-1-

MEMORANDUM **State of Alaska**
Department of Fish and Game

To:	File	*Date*:	1 June 2015
		FAX No.:	842-5514
		Telephone No.:	842-1599
From:	Neil Barten & Chris Peterson AB & AAB Dillingham Division of Wildlife Conservation Dillingham	*Subject*:	Moose 17C Twinning Survey

Introduction: On Tuesday May 19, Friday May 22, and Tuesday May 26 of 2015, we conducted moose twinning surveys in Unit 17C. We flew with Mike Hink (Tikchik Adventures, Dillingham) in a supercub aircraft. Although moose twinning surveys are conducted throughout Alaska by department personnel, this technique has not been part of the standard moose survey and inventory (S&I) in Unit 17B&C. Our intent with these surveys was to locate as many female moose accompanied with calves as we could, then record the number of calves with each parturient female. However, we recorded all moose seen, and classified them as bulls (based on the presence of velvet antlers), cows (adult moose without antlers), yearlings (moose that appeared to be smaller than an adult animal-easily done when moose were side by side, but more difficult on a single animal), and unknown sex and age (those moose that we saw but could not get a good enough look to determine sex or age).

By initiating twinning surveys in 17C this year, we hope to gain insight into the logistical and practical challenges of successfully conducting these surveys in the southern portion of Unit 17C. Major considerations would be whether we can successfully detect cow moose and their neonates in these habitats, especially if leaf out has occurred, and whether we can locate enough moose to get an adequate sample size for data analysis. If these challenges can be met, then we can discuss the larger issue of the merits of this activity as part of our annual S&I activities for moose in Unit 17B&C.

Timing of these surveys was based on data from Andy Aderman's moose research from Unit 17A and 18, where during the period of 1998-2013 mean calving occurred on 19 May, while 75% of the calves were born by 23 May.

Sampling protocol: Surveys were flown approximately 400 feet above ground level, with the pilot looking out one side of the aircraft and the observer the other side. When a moose was spotted, the pilot would circle back to the animal, and pass on the side providing the best lighting for both the pilot and observer to get a good look at the animal for sex and age identification as well as whether there were neonates present. The observer would collect a waypoint at the location. We also recorded a track file on the gps for each survey.
Moose were classified as bulls (based on presence of velvet antlers), cows, yearlings (based on short neck and smaller body size than adult cows) and calves (neonates). Bulls were classified based on the presence of small velvet antlers which seemed fairly easy to detect. Bulls were also generally darker in color than cows. Yearling's vs adults were a

little more difficult. When standing side by side there is an apparent size difference in age class, but, when alone, this classifying these two age classes can be more difficult.
The survey search methodology was to follow the river corridors and search the main stem of the rivers, any islands in the river, and any side streams that contained moose habitat. Due to the high amount of precipitation during the previous few weeks, the rivers and streams were at flood stage. Whether this helped by concentrating moose or hurt by pushing moose into timbered areas is not known. However we certainly detected a good number of moose on each of the surveys.

Since the comprehensive survey was completed over 3 separate flights, these will be listed below as separate surveys, and then summarized.

Flight 1

May 19: Chris Peterson conducted this survey with Mike Hink in the super cub aircraft.

Weather: The skies were 100% overcast, resulting in flat light and less than ideal detection for moose. Winds were blustery from the east, with winds at 10 mph at the beginning and increasing to 20 by the end of the survey. However, there was little turbulence and the winds did not affect our ability to fly and locate moose. There was intermittent drizzle during the survey.

Vegetation: Vegetation greenup was just beginning, with green tips on most willow branches, very little green on cottonwood branches, and some green showing in sedges. Sightability of moose was good even though the light was flat.

Area covered: Departed Shannon's airstrip and crossed the Wood River, then worked east along the north side of the Nushagak River to Portage Creek. From there they headed north to the mouth of the Iowithla River, then up the Iowithla to the Muklung Hills, then down the Muklung River to the Wood River, and back to Shannon's airstrip.

Findings: Recorded seeing 143 adult moose with 15 newborn calves. All calves looked very new and were right next to the cows. One cow with twins and one with a single calf had female brown bears with cubs within a couple of hundred yards.

Moose observations:

- 143 adult moose: 106 cows (10 with calves--5 with twins, 5 with singles), 29 yearling cows, 8 bulls
- Twinning rate for this survey was 50%

Flight Time: Depart Shannon's @ 1025 hrs. return @ 1435 hrs. (stopped at Portage for 15 minutes) = 4 hours and 10 minutes of flying time.

- Survey time = 4 hours and 10 minutes.
- Cost of survey = $350.00/hour wet rate = Approx. $1,400.00
- Survey charged to Dillingham Moose code: 11548101

Flight 2

May 22: Chris Peterson conducted this survey with Mike Hink in the super cub aircraft.

Weather: The skies were 100% overcast, resulting in very flat light and less than ideal detection for moose during the first half of the survey, slightly improved in the latter half of the survey. Winds were blustery from the east, with winds at 10 mph at the beginning and increasing to 20-25 by the end of the survey. However, there was little turbulence and the winds did not affect ability to fly and locate moose. There was intermittent drizzle during the survey.

Vegetation: Vegetation greenup was more progressed on this survey than that conducted on May 19, with willows green at least half of the branch, cottonwood buds had burst and were mostly green but not leafy, and sedges were predominantly green at the base and possibly 2-3 inches in height. Greenup combined with flat light resulted in poor sightability.

Area covered: Departed Shannon's airstrip and crossed the Wood River, then worked east along the north side of the Nushagak River to Portage Creek. From there they headed north to about 5 miles south of the Iowithla River, then headed back down the Nushagak River on the east channel, then worked the south side of the Nushagak River back to Dillingham.

Finding: Recorded seeing 156 adult moose with 17 calves.

Moose observations:

- 156 adult moose: 113 cows (12 with calves-- 4 with twins, 8 with singles), 38 yearlings, 5 bulls
- Twinning rate for this survey was 33%

Flight Time: Depart Shannon's @ 1105 hrs. return @ 1445 hrs. (stopped at Portage for 15 minutes) = 3 hours and 25 minutes of flying time.

- Survey time = 3 hours and 25 minutes.
- Cost of survey = $350.00/hour wet rate = Approx. $1,200.00
- Survey charged to Dillingham Moose code: 11548101

Flight 3

May 26: Neil Barten conducted a survey with Mike Hink in the supercub aircraft.

Weather: The skies were 50% overcast, very patchy, with sunlight streaming through during about 75% of the survey. This wasn't ideal for the survey as the shadows made it difficult to see into the forested areas and certainly lowered our sightability of moose. The air temperature at departure for the survey was 40 degrees F, with light east winds. We did not encounter any precipitation during the survey.

Vegetation: Realized pretty early in the flight that the leaf out was much advanced over just a few days ago. The cottonwoods and birch were leafing out pretty well, the willows varied from very early leaf out to advanced leaf out on some of the islands. The alders seemed to be the least leafed out of all the species. With greenup so much more advanced on this survey, it was hard to detect moose in many of the same habitats that revealed many moose a week earlier.

Area covered: Departed Shannon's airstrip and crossed the Wood River, then worked east along the Nushagak River to Portage Creek. Stayed on the north side of the river during this stretch, then headed north following the west channel of the Nushagak River, on up to the Kokwok River. At that point headed up the Kokwok, and then crossed over the Muklung Hills, and into the upper Muklung River, then down the Muklung and back to Dillingham.

Finding: There were a number of locations where Mike and Chris had seen half a dozen moose just 4 days prior to this survey where we saw only 1 moose. Not sure if it was completely due to poorer sightability or if the moose were spreading out at calving time and thus at a much lower density in any one given area.

Moose observations:

- 91 adult moose: 73 cows (20 with calves--12 with twins, 8 with singles), 9 yearlings, 6 unidentified sex and age (females, but not sure of yearling vs adult status), 3 bulls

- Twinning rate for this survey was 60%

Flight Time: Depart Shannon's @ 0905 hrs. return @ 1327 hrs. (stopped at Portage for 18 minutes) = 3 hours and 54 minutes of flying time.

- Survey time = 3 hours and 48 minutes.
- Cost of survey = $350.00/hour wet rate = Approx. $1,400.00
- Survey charged to Dillingham Moose code: 11548101

Summary: The cumulative cost in time and dollars for these surveys was 11 hrs. and 23 minutes of flying time, and a cost of $4,200.00. We were able to observe approximately 35 moose/hour, and 27 cows/hour of flying. Moose were easily seen up to leaf out, at which time they became progressively more difficult to find. Moose were most easily located on the islands of alder and willow within the floodplains of streams. The weather during these surveys was generally cool and overcast allowing us to fly during the late morning, early afternoon hours. During warmer periods, moose activity would probably be limited as the day warms, and survey efforts would be optimal in the early morning or late evening hours.

This experimental effort to conduct twinning surveys in unit 17C was fairly successful, in that we were able to locate numerous moose in close proximity to Dillingham and at a high enough density to acquire a fairly good sample size with minimum effort. However in looking at the data it seems we were early in the moose calving period which I presume was the main factor in low detection rates of cows with calves. Future efforts would probably be most effective by sampling every 2nd or 3rd day during the calving period to overlap the peak of calving and thereby increase the sample size of females with calves and acquire more data to estimate a twinning rate. Based on what we learned from this initial effort, I think we are better situated to assess the costs and benefits of considering this technique when critiquing the survey and inventory program for moose in Unit 17C.

Table 1. Twinning survey data.

Date	Bulls	Cows/0	Cows/1	Cows/2	Yearlings	Unk sex/age	Total[1]
5-19	8	96	5	5	29	---	143
5-22	5	101	8	4	38	---	156
5-26	3	53	8	12	9	6	91

[1] Surveys were flown over the same general area, so totals are not cumulative since the overlap in area between surveys certainly resulted in some cows being counted 2 or more times.

Cows observed during surveys: 5-19:106, 5-22:113, and 5-26:73
Cows observed with calves: 10 of 106, 12 of 113, and 20 of 73.
Twinning rate: 5 of 10 (50%), 4 of 12 (33%), and 12 of 20 (60%).

Cc:

Kim Jones, ADF&G, Palmer
Kevin Colson, ADF&G Palmer
Nick Demma, ADF&G Palmer
Mike Guttery, DFG biometrician in Palmer…
Dave Crowley, ADF&G King Salmon
Andy Aderman-TNWR, Dillingham
Pat Walsh-TNWR, Dillingham

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Appendix C. Cooperative agreement between the Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service-Togiak National Wildlife Refuge (TNWR) for developing a sightability correction factor for moose in TNWR, Southwest Alaska.

Project Title: Adapting to a warming climate: estimating moose abundance in declining snow cover.

C. Project Narrative

1. Statement of Need or Issues Addressed: Climate change has affected snow cover throughout Alaska (National Snow and Ice Data Center 2015), and the shift to a less-predictable snowpack has caused biologists from multiple agencies across Alaska to express concern about the potential bias of moose (*Alces alces gigas*) population estimates. Low-level aerial moose surveys were traditionally conducted after heavy snowfalls, when moose were known to have high sightability (the percentage of moose seen in the area searched; Caughly 1974 in Gasaway et al. 1986). During recent years, however, snow conditions have been inadequate for moose surveys throughout most of Alaska. Moose are an important subsistence species with 6,000-8,000 individuals harvested each year (Alaska Department of Fish and Game 2016) and relatively unbiased and precise estimates of abundance are needed to manage this large harvest. Concerns for our ability to estimate the abundance of moose have led to a scheduled moose workshop at the annual meeting of the Alaska Chapter of the Wildlife Society during 2016.

The Alaska Department of Fish and Game (ADF&G) has conducted sightability trials in boreal regions, during surveys with good snow conditions using radio-collared moose. Results from these studies estimate the sightability correction factor to vary from 1.1-1.8 (Kelly-Seaton 2014). This variation in sightability translates to underestimate of moose abundance ranging from 10-80% of the true abundance, making it difficult to detect changes in abundance. Additionally, sightability has not been quantified during surveys when there are poor snow conditions.

In western Alaska, poor snow conditions and, consequently, poor sightability have become a common occurrence, which causes unknown bias in the moose population estimate. A model is needed to predict the sightability of moose when surveys are conducted during poor snow conditions. In western Alaska, moose are known to be more concentrated in riverine drainages, unlike the more uniform distribution of moose in boreal regions. A predictive model would be useful for estimating the bias in moose population estimates throughout western Alaska. The utility of this research, however, will likely go beyond western Alaska. Given that sightability has not been quantified during surveys when there are poor snow conditions, a potential product of this research will be a test case that biologists could use as a starting point toward anticipating how they need to re-design their survey programs to get the data they need.

Togiak National Wildlife Refuge (TGK) is an excellent location to evaluate the sightability of moose and develop predictive models for western Alaska. The distribution and abundance of moose has changed during the past 25 years. For example, moose have recently expanded their range into the boundaries of Togiak National Wildlife Refuge and BLM Goodnews Block (TGK; Aderman et al. 2011). Fewer than 30 moose were recorded annually in Game Management Unit (GMU) 17A from 1980-1990, however, 84 moose were recorded in 1994. Moose continued to increase to a minimum of 1,166 individuals counted in 2011 (Aderman et al. 2011). Continued monitoring of moose is essential for developing regulatory proposals and recommendations to state Fish and Game Advisory Committees and federal Regional Advisory Councils, the Federal

Subsistence Board/Alaska Board of Game (Aderman et al. 2011). Additionally, monitoring moose abundance is important to fulfil two of the purposes for which TGK was created; restoring large mammal populations and providing opportunities for continued subsistence uses by local residents (Aderman et al 2011).

2. Project Goals and Objectives: The Project Goal is to develop a model that would be used to estimate moose abundance with consistency for TGK and have application to most of the Western Alaska LCC and beyond. Sampling Objectives are to 1) Develop a survey-specific Sightability Correction Factor (SCF_C) for moose surveys conducted during 4 sampling periods (Spring and Fall 2016-2017) with 15% relative precision at the 95% confidence level. In other words, our objective is to be 95% confident that our estimate of a SCF_C on TGK will be within 15% of the true sightability for the survey period, 2) Develop a model for predicting sightability of moose on TGK using attributes known to affect sightability of moose (snow cover, search rate, habitat category) with 25% precision at the 90% confidence level, and 3) Estimate abundance of moose with 25% precision at the 90% confidence level and maximize accuracy using a SCF_C.

3. Project Activities, Methods and Timetable: Activities include: developing the research protocol, pre-survey logistical planning and preparations, implementing the surveys, analyzing data and reporting results. A draft research protocol (Benson et al. 2016) has been developed and is currently being peer-reviewed. Pre-survey preparations began in 2015 and included ordering and deploying 19 GPS collars on bull moose, procuring Bluetooth-enabled GPS units to pair with iPads used for survey navigation and data collection, downloading and customizing the ArcGIS Collector App (ESRI, Redlands, CA) on Ipads, and procuring fleet and non-fleet survey aircraft. Contingent upon securing all funding, survey implementation is planned to occur during each of 4 sampling periods (Spring and Fall 2016-2017) and includes stratification, surveys, and sightability trials. The rationale for the Spring (approximately March) and Fall (approximately October) time frame is that this will ensure the widest range in snow conditions. Snow cover traditionally reaches its peak in March. Snow is generally absent in October, although leaf fall has occurred and day length is relatively long.

Moose abundance estimates will be obtained via the GeoSpatial Population Estimator (GSPE; Ver Hoef 2001, 2008) with methodology described by Kellie and DeLong (2006).

Stratification-Direct aerial observation will be used for initial stratification and each sample unit (SU) will be classified as high (>3 moose), or low (0-3 moose) based on observations of moose, moose tracks, and moose habitat (Kellie and Delong 2006). We will estimate abundance using data collected from 100 SUs (70 high- and 30 low-density). This allocation is based on two sources: 1) Kellie and Delong (2006) suggest a minimum of 50 samples be taken in high density strata and 30 samples in low density, and 2) In 2012, Brian Taras (ADF&G Biometrician personal communication) recommended a 70:30 allocation of high:low density strata after simulations using data from GMU 21E in western Alaska. Within each stratum, 80% of the sample will be selected randomly (every unit has an equal probability of being selected) and 20 % of the sample will be selected based on a combination of 1) a systematic sample of some of the units on the periphery of each stratum (to reduce the variance; Kellie and Delong 2006), and

2) subjective selection of SUs located in regions that will require a separate population estimate (Kellie and Delong 2006).

Survey flights-Up to 4 survey crews each composed of a single pilot–observer pair flying in aircraft with tandem seating will be assigned SUs in different parts of the survey area. Each survey crew will know the assignments of the other survey crews and pilots will need to maintain radio contact for collision avoidance. Survey methodology will generally follow Kellie and Delong (2006). Search intensity will depend on the amount and type of habitat, degree of snow cover, and number of moose encountered. For each SU the observer will record start and stop times, snow cover (complete, incomplete, absent) and number of moose by group. Moose group locations and size will be collected via Collector app downloaded on an iPad paired with a Bluetooth-enabled GPS. If a collared moose is observed, additional covariate data including composition of group (within 100 m of the collared moose), habitat (tundra, shrub, forest) and snow cover (complete, incomplete, absent) within 10 m of the moose, and activity (lying, standing, or moving) will be recorded electronically, using iPads, at the time of data collection. As a secondary, backup method in the event of iPad data recording problems, data for each SU will be recorded on individual data forms. Upon completion of a SU, the survey crews will report to the telemetry crew whether any collared moose were observed.

Sightability trials-Simulations by Benson (2014) demonstrated that 40-50 sightability trials are required to estimate true sightability of 1.3-1.6 with 15% relative precision and 95% confidence. Because we have no previous estimate of sightability on TGK, we are taking a conservative approach, by using a relatively high sample size for low sightability. We will follow methods described by Kellie and Paragi (2010 in Seaton et al. 2014):

> ”There are two different scenarios currently employed to conduct trials: 1) random trials conducted during the survey, and 2) nonrandom trials conducted during the survey. Random trials are conducted only when a collared moose occurs within a SU randomly chosen for the GSPE survey. Nonrandom trials conducted during a survey are collected by directing survey teams to survey in SUs that were not chosen for GSPE estimation. These SUs are usually included covertly along with random GSPE SUs so that survey teams are unaware that they are being tested. Nonrandom SUs added to the survey to augment sightability trials should not be used for population estimation. Thus, nonrandom SUs are an additional survey cost specific to sightability estimation.”

An aircraft (Cessna C-185 or Found) and telemetry crew (pilot and observer) will be dedicated to locating radiocollared moose daily for use in sightability trials. The telemetry crew will assign both random and nonrandom SUs to the survey crews. The survey crew surveys the assigned SU recording start and stop times, snow cover and number of moose by group. As noted previously, when a collared moose is observed, additional covariate data including composition of group (within 100 m of the collared moose), habitat (tundra, shrub, forest) and snow cover (complete, incomplete, absent) within 10 m of the moose, and activity (lying, standing, or moving) will be recorded by the survey crew. Whenever a survey team completes a SU, they will make radio contact with the telemetry crew and report whether they saw a collared moose and relay other related data they recorded about the collared moose. If the survey team and telemetry crew can agree that the collared moose was seen (by GPS location, group size/composition, habitat type), then the telemetry crew can record the information and move forward. Sometimes collars are not visible from the air. If the survey team failed to see the collar but saw moose in the study unit, the telemetry crew must determine whether the survey crew saw the collared moose. This is done by one of three methods: 1) the survey and telemetry crews exchanging location and composition information by radio; or 2) both crews return to the unit and the telemetry crew points out the moose to the survey team, or 3) the survey crew's GPS track and moose composition information is checked at the end of the day against the telemetry crew's knowledge of location and composition of the collared moose group. The telemetry crew makes the determination on which method is necessary in order to make the decision on whether or not the collared moose was seen.

Analysis- For the abundance estimates, we will follow instructions for the GSPE in Kellie and Delong (2006, pp 36) using program R.

For the sightability models, data will be fitted to the following logistic regression model to estimate probability of detection for individual moose:

$$\hat{\pi}_{ij} =$$
$$(\hat{\ }_0 + \hat{\beta}_1 GS_{ij} + \hat{\beta}_2 Hab_{ij} + \hat{\beta}_3 Act_{ij} + \hat{\beta}_4 Snow_{ij})$$
$$1 + (\hat{\ }_0 + \hat{\beta}_1 GS_{ij} + \hat{\beta}_2 Hab_{ij} + \hat{\beta}_3 Act_{ij} + \hat{\beta}_4 Snow_{ij})$$

for *i*=1,… *n* moose, on *jth* sample unit

Where,

GS (Group Size) is number of individuals within 100 meters of the sighted moose. *Hab* (Habitat) within 10 m of the moose is a categorical variable (tundra, shrub, forest) *Act* (Activity) is categorical (moose is lying, standing, or moving) *Snow* cover within 10 m of moose (complete, incomplete, absent)

Additionally, several covariates will be recorded for each SU, and we expect the following two covariates will have good predictive power:

Snow cover is a categorical variable (complete, incomplete, absent).
Survey time for each sample unit (rounded to nearest minute)

Data will be analyzed using WinfoNet (ADFG 2016) and program R (2015).

Timetable
Activity________________________Completion Date
Radio-collar Moose Oct 2015
Study design Feb 2016
1st GSPE moose survey Mar 2016
2nd GSPE moose survey Nov 2016
3rd GSPE moose survey Mar 2017
4th GSPE moose survey Nov 2017
Abundance/Sightability models Jan 2018

4. Data Management: Moose group locations will be collected via Collector app downloaded on an iPad paired with a Bluetooth-enabled GPS. Covariate data for collared moose will be entered electronically, using iPads, at the time of data collection. Data will be downloaded, archived, and backed-up after each day of data collection.

Should the iPads fail, data will be recorded on paper data entry forms and entered into WinfoNet as described by Kellie and Delong (2006):

Survey data will be entered each evening of the survey. The section “Editing Observation Data” in the GSPE Software User's Guide contains detailed instructions on entering the survey data (DeLong 2006). After data entry is completed, or during break points in the entry, data will be downloaded from WinfoNet and archived. Data entry will be checked against original data before running any analyses (Kellie and Delong 2006).

Metadata
All data sets will be documented with the minimum attributes necessary to meet the minimum requirements of the Dublin Core (ISO 15836:2009) and Project Open Data (https://project-opendata.cio.gov/v1.1/schema/) metadata standards. All geospatial data will be documented with the minimum set of attributes that are required to comply with the ISO 19115-2:2009 (Geographicinformation -- Metadata -- Part 2: Extensions for imagery and gridded data) standard in additionto the Dublin Core and Open Data standards.

5. Anticipated Products:
Our primary product is a model that can be used to predict sightability of moose across western Alaska and beyond. The model and R code will be written as a manuscript for submission in the Wildlife Society Bulletin and will be documented for easy use by our agency partners. The model could also be incorporated into the WinfoNet program to reach a broader audience. Results will be presented at state and federal advisory committee/council meetings, LCC webinars, a workshop specific to this issue and other appropriate venues. Estimates will inform agencies and stakeholders about the abundance of moose in a given area so that harvest recommendations and decisions are made with more up to date information.

6. Project Monitoring and Evaluation: The data quality will be evaluated after each of four sampling events. The sightability model will be validated to determine whether the model meets our precision targets and to evaluate the predictive power of the model.

7. Sustainability: Periodic (~3-5 years) moose abundance estimates for TGK will occur into the foreseeable future. It is anticipated these future efforts will continue to be cooperative between the U. S. Fish & Wildlife Service, ADF&G, and Bureau of Land Management (BLM)-Anchorage District. We anticipate that Togiak Refuge will provide the primary funding for obtaining moose abundance estimates in GMU 17A and GMU 18 (south of and including the Kanektok River drainage) with ADF&G providing aircraft and observer support. We anticipate that BLM will provide funding for surveys in the BLM Goodnews Block (southern GMU 18).

8. Literature Cited

Aderman, A., J. Woolington, P. Perry, and G. Beyersdorf. 2011. Moose demographics monitoring on and adjacent to Togiak National Wildlife Refuge, Alaska: Study Plan and Protocol.

ADFG 2016. WinfoNet Moose Surveys. https://winfonet.alaska.gov/index.cfm?fuseaction=sandimoosesurveys.documentation

Benson, A., G. Frye, H. Maier, M. Cobb. P. Walsh, A. Aderman, and B. Seppi. 2016. Estimation of moose abundance and sightability: site-specific research protocol for Togiak National Wildlife Refuge and BLM Goodnews Block.

DeLong, R. A. 2006. Geospatial population estimator software user’s guide. Alaska Department of Fish and Game. Fairbanks, AK, USA.

Gasaway, W. C., S. D. DuBois, D. J. Reed, S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biological Papers of the University of Alaska 22:1–108.

Kellie, K. A., R. A. DeLong. 2006. Geospatial survey operations manual. Alaska Department of Fish and Game. Fairbanks, Alaska, USA.

National Snow and Ice Data Center. 2015. https://nsidc.org/cryosphere/snow/climate.html

Seaton, K. A .K., T. P. Paragi, B. D. Taras, and J. M. Ver Hoef. 2014. Evaluating options for improving the GSPE performance and developing a sightability correction factor. Federal Aid Final Research Performance Report. Alaska Department of Fish and Game. Fairbanks, AK, USA.

R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Ver Hoef, J. M. 2001. Predicting finite populations from spatially correlated data. 2000 Proceedings of the Section on Statistics and the Environment of the American Statistical Association, pp. 93-98.

Ver Hoef, J. M. 2008. Spatial methods for plot-based sampling of wildlife populations. Environmental and Ecological Statistics 15:3-13.

9. Map or Description of Project Area: The 2016 sampling frame is comprised of 1,125 SUs designed for the GSPE (Fig. 1), sample units are contained within 4 GMUs (GMU 18 = 485 SU, GMU 17A=462 SU, GMU 17B= 8 SU, and GMU 17C=170 SUs). The SUs are based on 2 minutes of latitude and 5 minutes of longitude (Kellie and Delong 2006), making each grid cell or sample unit approximately 17.6 km^2 or 6.8 miles^2.

Figure 1. GSPE Sample frame, sample units, and GMU boundaries for Togiak National Wildlife Refuge.

10. Stakeholder Referrals:
Dan Dunaway, Member-Bristol Bay Federal Subsistence Regional Advisory Council and Nushagak Fish and Game Advisory Committee, Dillingham, email: dlgdunaway@gmail.com

Peter Julius, Tribal Administrator-Native Village of Goodnews Bay, email: goodnews907@hotmail.com

Dave Crowley, ADF&G Area Biologist-GMU 9/10, King Salmon, email: dave.crowley@alaska.gov

11. Description of Organizations Undertaking the Project:
The **U.S. Fish and Wildlife Service** manages16 national wildlife refuges in Alaska, totaling >76 million acres. These refuges are part of a National Wildlife Refuge System dedicated specifically to wildlife conservation.

Andy Aderman-Program Manager: review study design, develop and submit LCC full proposal, procure non-fleet aircraft as needed, schedule and coordinate surveys, present results at state and federal advisory committee/council meetings, LCC webinars, and other appropriate venues. Contact: Andy Aderman, Togiak NWR, P.O. Box 270, Dillingham, AK 99576, 907-842-8406 (phone), 907-842-5402 (fax), email: andy_aderman@fws.gov

Andy Aderman has worked as a wildlife biologist in Alaska since 1992. He's worked at TGK since 1994 where his primary responsibilities include acting as program leader for moose and caribou monitoring efforts and representing the Refuge at federal Subsistence Regional Advisory Council and state Fish and Game Advisory Committee meetings. Andy has coordinated and conducted most of the moose surveys on TGK from 1995 to present and has participated in ADF&G-led surveys in adjacent areas. Andy has co-authored several journal articles on caribou and moose research in southwestern Alaska.

Anna-Marie Benson-Principal Co-Investigator: draft the study design, run simulations, develop the sightability model, present results at LCC webinars, in the Wildlife Society Bulletin, and other appropriate venues.

Contact: Anna-Marie Benson, U.S. Fish & Wildlife Service, 101 12th Ave, Fairbanks, AK 99701, 907-456-0386 (phone), 907-456-0447 (fax), email: anna-marie_benson@fws.gov,

Anna-Marie Benson has worked as a statistician for the FWS (refuges) since 2010. She has an MS in Statistics and an MS in Biology, and has worked on inter-agency teams related to estimating the abundance of moose.

Project Co-Investigators:
Graham Frye-draft the study design, run simulations, and develop the sightability model.
McCrea Cobb-develop protocols for data capture and storage using Ipads, and participate as a survey observer.
Hilmar Maier-draft the study design.

Ryan Mollnow-provide funding.
Patrick Walsh-review study design, participate as a survey observer, and provide 2 survey aircraft and funding.
Spencer Rearden-participate as a survey observer.
Dom Watts- participate as a survey observer.

The **Alaska Department of Fish and Game**-Division of Wildlife Conservation's mission is to conserve and enhance Alaska's wildlife and habitats and provide for a wide range of public uses and benefits.

Neil Barten-Principal Co-Investigator: review study design, participate as a survey observer, provide a pilot and tandem aircraft for 1 survey, present results at state advisory committee meetings, provide bunkhouse space during surveys if needed.

Neil Barten, Alaska Department of Fish & Game, P.O. Box 1030, Dillingham, AK 99576, 907-842-2334 (phone), 907-842-5514 (fax), email: neil.barten@alaska.gov

Neil Barten has worked as a field biologist in Alaska since 1983. He has participated in moose population surveys (trend count and GSPE) from fixed wing aircraft for approximately 20 years and is very familiar with recording data on moose numbers, composition, and habitat characteristics. Neil has 10 years of experience conducting moose surveys, where radiocollared moose were used to determine moose sightability (survey and individual levels) to derive a population estimate. He has worked out of the Dillingham ADF&G office during the past two years, and has conducted a GSPE moose survey that includes portions of TGK.

Project Co-Investigators:
Dominic Demma-review study design, obtain IACUC approval and is lead for moose captures.
Phillip Perry- participate as a survey observer
Patrick Jones- participate as a survey observer

The **Bureau of Land Management** has the privilege of protecting and maintaining some of the Nation's most unique treasures in Alaska. We manage 72 million acres in Alaska, together with some 220 million acres of federal subsurface minerals. These lands provide for a variety of multiple uses throughout Alaska, all of which contribute to the well-being of local communities through economic activities, social contributions, and land stewardship programs.

Project Co-Investigators:
Bruce Seppi-provide funding

The **Wildlife Management Institute** is a private, nonprofit, scientific and educational organization, dedicated to the conservation, enhancement and professional management of North America's wildlife and other natural resources.

Project Co-Investigators:
Chris Smith-in conjunction with Western Alaska LCC staff, facilitate an Alaska based workshop on estimating moose abundance in declining snow cover.

12. Statement Regarding Single Audit Reporting: My organization was not required to submit a Single Audit report last year.

Preferred Approach

After discussions with other biologists around the state and with Western Alaska LCC staff Karen Murphy and Joel Reynolds, it was evident that southwestern Alaska wasn't the only area affected by low snow falls/warmer winters which hindered completion of traditional moose surveys in recent years. Concerns for our ability to estimate the abundance of moose during winters with suboptimal snow cover led them to a schedule a 1-day moose workshop (at the annual meeting of the Alaska Chapter of the Wildlife Society in 2016) to coordinate discussions among State and Federal biologists. Due to declining revenues, the State of Alaska is facing severe budget deficits and many programs are being scaled back or cut altogether. This includes a travel ban for all State biologists. The moose workshop has been cancelled as the LCC does not have funding to support travel of the key state participants.

The preferred approach is to add $50,000 funding (from the National LCC network) to the $100,000 requested from the Western Alaska LCC (for the development and testing of the moose sightability model). This additional funding would: allow greater participation of ADF&G biologists in conducting surveys and sightability trials ($20,000); provide travel support ($20,000) for key ADF&G staff to participate in a workshop on monitoring moose populations in suboptimal snow conditions; and, provide the Wildlife Management Institute, in partnership with LCC staff, funds ($10,000) to facilitate the aforementioned workshop. The appropriate forms from these partners are included in case this project is funded.