OPERATIONAL PLAN FOR INTENSIVE MANAGEMENT OF MOOSE IN UNIT 13 DURING REGULATORY YEARS 2016–2021

Prepared by:

DIVISION OF WILDLIFE CONSERVATION

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This operational plan has been prepared by the Alaska Department of Fish and Game (ADF&G) to provide supporting information on the intensive management (IM) plan for moose in Unit 13 during regulatory years (RY) 2016–2021 (RY = 1 July–30 June, e.g., RY12 = 1 July 2012–30 June 2013). The IM plan for moose in Game Management Unit (GMU) 13 is found in Title 5, Alaska Administrative Code, Section 92, Part 121 (abbreviated as 5 AAC 92.121)[1]. Based on the biological and management information for this area (Appendix A), this operational plan describes rationale for evidence of limiting factors; choice of indices for evaluating treatment response; and decision frameworks on implementation, suspension, or termination for predation control, habitat enhancement, and prey harvest strategies. *Intensive Management Protocol* (ADF&G 2011) describes the administrative procedures and the factors and strategies in adaptive management of predator-prey-habitat systems to produce and sustain elevated harvests of caribou, deer, or moose in selected areas of Alaska. The IM plan for moose in GMU 13 has been developed based on the recommendation of the Copper Basin, Denali, Paxson, and Tok Cutoff Advisory Committees, and at the request of the Alaska Board of Game (BOG).

BACKGROUND

Historically, Unit 13 has been an important area for moose hunting in Alaska. Hunting seasons were long, with both fall and winter seasons and the annual harvests reflect this averaging more than 1,200 bulls and 200 cows during the late 1960s and early 1970s. The moose population in Unit 13 began to decline during the early 1990s due to severe, deep snow winters (1988–1994) and increased wolf predation. As a result, moose harvest regulations were restricted beginning in 1990 while the population continued to decline.

In 1994, the Alaska legislature passed the intensive management law. This law states that the highest and best use of most big game populations is to provide for high levels of harvest for human use. The following year the Alaska Board of Game designated Unit 13 an intensive management area with the primary objective of increasing the human harvest of moose and caribou (Tobey 2003). During this time the board also decreased the spring postharvest wolf population management objective to 135–165. Methods and means for wolf hunting and trapping remained unchanged until a proposition eliminating same-day-airborne (SDA) harvest passed during a November 1996 statewide referendum. In 1998, the Alaska legislature amended the intensive management law by requiring the board to establish population and harvest goals and seasons for intensively managed big game populations. In response, the board identified the Unit 13 moose population as important for providing high levels of harvest for human consumptive use, and established population and harvest objectives in March of 1999. During this time the hunting bag limit for wolf in Unit 13 was also increased to 10 wolves per day.

During the fall of 1999 and 2000, the Unit 13 wolf abundance estimate peaked at more than 500 wolves (>12 wolves/1,000km^2) - the highest in more than 25 years. This peak was accompanied by deep snow winters of 1999–2000 and 2000–2001 and a 47% decline in moose abundance between 1987 and 2001. In the fall of 2000 the moose to wolf ratio was estimated at approximately 31 moose for every 1 wolf based on unit-wide wolf and moose abundance estimates. Considering

[1] Regulatory numbers for existing IM programs formerly under 5AAC92.125 were divided into groups and given new numbers in October 2012 (see IM Plan template).

that wolves in Unit 13 continue to prey on moose even when caribou are present (Ballard et al. 1987), this extremely low ratio was expected to keep the moose population in a steady decline. Between 1993 and 2001 Unit 13 moose harvest declined 63% with the lowest reported harvest in 40 years occurring in 2001 (468 moose). Past research identified that wolf populations are not naturally regulated by the density of their prey until prey densities become very low, with the end result of management inaction being an indefinite low-density equilibrium among predators and their prey (Gasaway *et al.* 1983).

In response to the decline in moose abundance and harvest, the Alaska Board of Game adopted a wolf control implementation plan for Units 13A, 13B, and a portion of 13E in March 2000. The stated objective of the plan was to "reverse the decline of the moose population within Unit 13 and maintain a population size of 20,000 to 25,000 moose and an annual human harvest of 1,200 to 2,000 moose by the year 2005". At this meeting the Board also liberalized the use of snowmachines for taking wolves. During the spring of 2000 the state legislature passed a measure (SB267) to allow same-day-airborne taking of wolves within the wolf control implementation areas, which was adopted by the board soon after. Between March and November 2000, land and shoot taking of wolves was allowed in the wolf control implementation area if the hunter was at least 300ft from the aircraft (Kellyhouse 2006). However, in November the Alaska Land-And-Shoot Referendum was held and voters adopted a measure which prohibiting the taking of wolves by the method of land and shoot. Two year later the Alaska legislature passed a bill effectively reinstating SDA predator control activities. In January 2004, land and shoot was reinstated (without a distance requirement) in the wolf control implementation areas in 13A, B, and E under a permit system.

Beginning in January 2004, active wolf control using SDA methods was implemented by permit and the following prey and predator population objectives and estimates were specified in the March 2005 board findings:

- Unit 13 population and harvest objectives:
  - Unit 13A, 3,500–4,200 moose with harvest objective of 210–420.
  - Unit 13B, 5,300–6,300 moose with harvest objective of 310–620.
  - Unit 13C, 2,400–3,200 moose with harvest objective of 155–350.
  - Unit 13E, 5,000–6,000 moose with harvest objective of 300–600.

- Unit 13 Fall 2004 moose population estimates:
  - 2,500 moose in Unit 13A
  - 3,800 moose in Unit 13B
  - 1,200 moose in Unit 13C
  - 4,000 moose in Unit 13E

- Unit 13 Average Harvest 2000–2004:
  - 155 bull moose in Unit 13A
  - 142 bull moose in Unit 13B

- 74 bull moose in Unit 13C
- 100 bull moose in Unit 13E

- Spring wolf IM objective: 135–165 wolves.

- Unit 13 Spring 2004 wolf population estimate:
  - 230

Additionally, the board reauthorized the Wolf Predation Control Implementation Plan for Unit 13 with program objectives designed to stop the decline of the moose population within the wolf predation control area and to maintain the following moose composition and density objectives during fall surveys:

- Unit 13A, 1.0 cows per square mile and 25 calves per 100 cows.
- Unit 13B, 1.2 cows per square mile and 30 calves per 100 cows.
- Unit 13C, 1.5 cows per square mile and 30 calves per 100 cows.
- Unit 13E, 0.9 cows per square mile and 30 calves per 100 cows.

- Unit 13 Fall 2004 moose composition and density estimates:
  - Unit 13A, 0.8 cows per square mile and 22 calves per 100 cows.
  - Unit 13B, 0.8 cows per square mile and 23 calves per 100 cows.
  - Unit 13C, 0.7 cows per square mile and 10 calves per 100 cows.
  - Unit 13E, 0.6 cows per square mile and 24 calves per 100 cows.

- IM moose population objective for Unit 13: 17,000–21,400 moose
- Maintain 25 bulls:100 cows with 10 yearling bulls:100 cows
- Unit-wide moose harvest objective: 1,050–2,180 moose

Initially, permittees could only use land-and-shoot same-day-airborne methods; however, in 2005 subunit 13C was added to the plan and aerial shooting was authorized (Kellyhouse 2006). In October 2010, the Board of Game re-authorized the wolf control implementation plan through regulatory year 2015 and updated the moose population and composition estimates as follows:

- Unit 13 Fall 2009 moose population estimates:
  - 3,530 moose in Unit 13A
  - 4,630 moose in Unit 13B
  - 1,610 moose in Unit 13C
  - 4,940 moose in Unit 13E

- Unit 13 Average Harvest 2005–2009:
  - 223 bull moose in Unit 13A

- 182 bull moose in Unit 13B
- 66 bull moose in Unit 13C
- 147 bull moose in Unit 13E

- Unit 13 Fall 2009 moose composition and density estimates:
  - Unit 13A, 0.8 cows per square mile and 22 calves per 100 cows.
  - Unit 13B, 0.8 cows per square mile and 23 calves per 100 cows.
  - Unit 13C, 0.7 cows per square mile and 10 calves per 100 cows.
  - Unit 13E, 0.6 cows per square mile and 24 calves per 100 cows.

- Unit 13 Spring 2010 wolf population estimate:
  - 170–190 wolves

The current Unit 13 Predation Control Area is approximately 15,413 square miles and consists of all lands within Units 13A, 13B, 13C, and that portion of Unit 13E east of the Alaska Railroad, except National Park Service and other federal lands where same-day-airborne take of wildlife is not allowed (Figure 1). Unit 13D is excluded from the plan area due to the difficult terrain, thick vegetation, and competing predation effects by brown and black bears on moose. However, it should be noted that the natural density of wolves in the subunit has always been relatively low.

Moose across the Unit 13 treatment area have generally increased since IM program inception with numbers of cows peaking in 2012. Between 2012 and 2013, cow numbers increased further in Unit 13A, but may have declined slightly in the remainder of the treatment area. Observed bull numbers increased substantially during the early years of the program peaking in 2013. The Unit 13 IM program has been inactive since 2014 and estimates of Unit 13 moose abundance have declined since 2016.

Current (Fall 2017) moose population estimates by subunit are:

- Unit 13 moose population estimate:
  - 3,445 moose in Unit 13A
  - 4,111 moose in Unit 13B
  - 2,390 moose in Unit 13C
  - 6,324 moose in Unit 13E

Estimates of wolf abundance have increased notably since 2014, when the Unit 13 wolf population was estimated to be well below the spring population objective.

- Unit 13 spring 2017 wolf population estimate:
  - 250 wolves

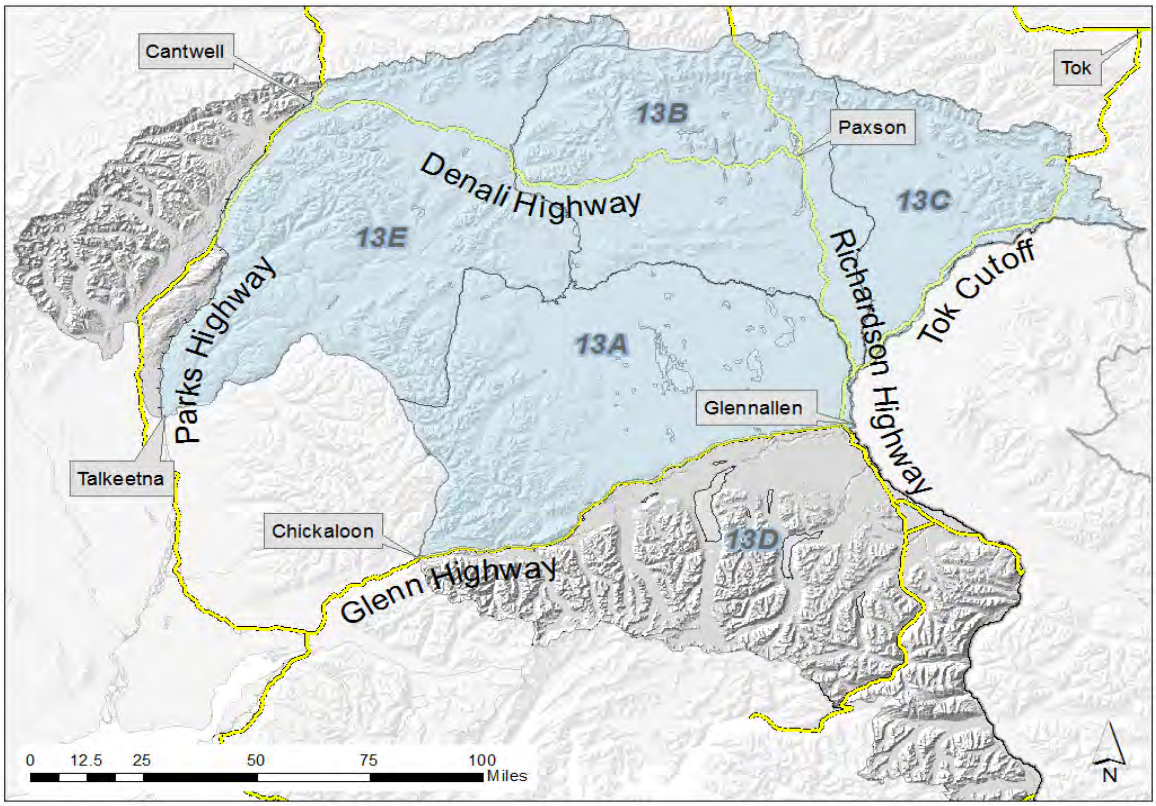

Figure 1. Area under intensive management for moose in Unit 13**.**

ADAPTIVE MANAGEMENT FRAMEWORK

Adaptive management is designing programs to maximize what can be learned from field experiments for potential application elsewhere, not simply modifying management in light of experience (National Research Council 1997:122). Managers wishing to use the best available information for management decisions or recommendations often need to generate new information for specific field situations (National Research Council 1997:174). Any section of the following framework may be modified as new information comes to light in the study area or the scientific literature. Lack of an anticipated response may require evaluation of additional criteria or a research project to understand which additional factors may be influencing the system and whether they are feasible to manage.

I. TREATMENTS

A. *Predation Control:*

Bans on the same-day-airborne take of wolves in 1987 and again in 1996 facilitated the growth of the wolf population in Unit 13. During the early 1990s, the moose population declined after several years of deep snow and the record high wolf population. As the moose population declined, calf predation by brown bears accentuated the decline. In an

effort to reinitiate predation control activity, the BOG established a wolf predation control area covering much of Unit 13 in 2000 although no aerial action was taken until January 2004 - when land and shoot wolf control by state permittees was initiated. Starting in 2005 moose abundance estimates indicated an increase in the population, and the population continued to increase until 2015, when moose population objectives were met or exceeded in three of five Unit 13 administrative units. Further control of predation by wolves is necessary to increase the moose population to meet objectives in Units 13B, 13C, and 13E, as well as increase and maintain the available surplus necessary to meet harvest objective levels.

As moose population and harvest objectives are realized, control efforts will be adjusted accordingly. The pre-control population estimate of wolves was 230 to 250 was compiled from sealing records, and trapper and pilot observations. The objective of the wolf reduction plan is to reduce the pre-control population of wolves by 60–70% resulting in a management objective of 135-165 wolves for Unit 13. Federal land closed to aerial control in the north, as well as the exclusion of 13D from the predation control area, is expected to provide refugia for wolves in Unit 13. Historical predator and prey management in Unit 13 indicates that when the late-winter (spring) wolf population was maintained at 135–165 wolves, annual moose survival was adequate to allow the moose population to increase.

Unit-wide wolf harvest is distributed between same-day-airborne take, hunting, and trapping. The level of wolf harvest has generally been within objective since 2005 (Table 1). The use of same-day-airborne techniques allows wolf densities to be maintained at objective levels in the central portion of the IM area which is the most important winter habitat for moose in Unit 13. Hunting and trapping harvest along road and trail systems supplement predation control activities in Unit 13. Wolf harvest by hunters and trappers, while ineffective in reducing the wolf population, has proven an important tool for maintaining desired population levels for short periods of time. These complementary programs can effectively maintain the unit-wide wolf population within objectives.

Multiple measures have been taken to improve survival of moose in this area, including the liberalization of seasons and bag limits for wolves, brown bears, and black bears. The current wolf hunting and trapping seasons are effectively maximized and any further extensions into the summer season are not likely to increase the wolf harvest by any significant amount. Currently there are year-round hunting seasons for brown and black bears (resident tag requirement waived) including legal harvest of both brown and black bears over bait stations.

Presently known alternatives to predation control for reducing the number of predators are ineffective, impractical, or uneconomical in Unit 13. Hunting and trapping conducted under authority of ordinary hunting and trapping seasons and bag limits are not effective reduction techniques in sparsely populated areas such as Unit 13.

The inherent wariness of wolves, difficult access, increased costs of trapping, and relatively poor pelt prices limit the moderate wolf harvest rates in Unit 13. Application of the most common sterilization techniques (i.e., surgery, implants, or inoculation) are not effective

Table 1. Wolf abundance estimates and removal in the wolf assessment area of the Unit 13 Predation Control Area.

Period	RY	Harvest removal		Dept. control removal	Public control removal	Total removal	Spring abundance (variation)
		Trap	Hunt				
Year 0[a]	2000	166	93	0	0	269	220
Year 1	2001	140	83	0	0	223	230
Year 2	2002	62	81	0	0	143	250
Year 3[b]	2003	70	51	0	125	246	230
Year 4	2004	37	32	0	67	136	230
Year 5[c]	2005	61	23	0	61	145	157
Year 6[d]	2006	47	25	0	33	106	160
Year 7	2007	49	9	0	33	91	153
Year 8	2008	38	26	0	55	121	144
Year 9	2009	42	18	0	23	83	180
Year 10	2010	46	10	0	103	159	146
Year 11	2011	16	35	0	40	91	104
Year 12	2012	37	21	0	0	59	191
Year 13	2013	26	16	0	60	102	–
Year 14	2014	35	18	0	0	53	84
Year 15	2015	40	16	0	0	56	–
Year 16	2016	76	16	0	0	94	–
Year 17	2017	53	36	0	0	89	250

[a] IM plan first adopted.
[b] Land-and-shoot for wolves is authorized.
[c] Unit 13C is added to IM area.
[d] Aerial shooting of wolves is allowed.

reduction techniques because they require immobilization of individual predators, which is prohibitively expensive in remote areas. Relocation of wolves is impractical because it is expensive, ineffective, and it is very difficult to find publicly acceptable places to relocate predators. Stocking of moose is impractical because of capturing and moving expenses, as well as the risk of disease transmission.

B. *Habitat Enhancement:*

There are no habitat enhancement projects proposed for this plan. However, the use of prescribed fire to replace wildfire could result in more favorable browse conditions for moose. Due to the size and remoteness of much of Unit 13 fire is likely the best option for extensive habitat improvement. We intend to work with area natural resource managers so that wildfires can potentially convert climax plant communities to earlier seral stages, thereby improving the availability of moose browse. The only recent large-scale burn that has occurred in Unit 13 is the 41,000 acre[2] Alphabet Hills Prescribed Burn in 2003 and 2004 on the border of Unit 13A and 13B. Further burning under an updated version of this

plan is still being evaluated, though it is contingent upon meeting burn prescriptions and having available suppression resources.

We will consult with landowners on mechanical treatment of late seral vegetation communities close to the villages of Copper Center, Gakona, Glennallen, Gulkana, and Tazlina. Mechanical treatments could result in a positive vegetative response for moose, as well as create protective firebreaks that could facilitate the implementation of future prescribed burns.

C. *Prey Harvest:*

Current moose harvest regulations were designed to keep the harvest within sustainable yield and limited to only bulls when the objective is population growth (Table 2).

Table 2. Moose harvests in assessment area Unit 13, regulatory years 2000 through 2014.

		# of	Reported Harvest		Estimated Harvest		Total	Other	
Period	RY	Hunters	Malt	Female	Unreported	Illegal	Harvest	Mortality	Total
Year 0[a]	2000	4,142	549	3	25	25	602	75	677
Year 1	2001	3,586	462	0	25	25	512	75	587
Year 2[b]	2002	3,451	573	0	25	25	623	75	698
Year 3	2003	3,517	627	0	25	25	677	75	752
Year 4	2004	3,616	610	0	25	25	660	75	735
Year 5	2005	3,825	571	0	25	25	621	75	696
Year 6	2006	4,182	686	0	25	25	736	75	811
Year 7	2007	3,935	645	0	25	25	695	75	770
Year 8	2008	4,340	730	1	25	25	781	75	856
Year 9[c]	2009	4,432	861	1	25	25	912	75	987
Year 10[d]	2010	5,106	937	1	25	25	996	75	1,071
Year 11[e]	2011	4,943	950	1	25	25	1,001	100	1,101
Year 12	2012	5,600	705	5	25	30	772	75	847
Year 13	2013	5,757	714	2	25	30	778	75	853
Year 14	2014	5,394	924	4	25	30	988	75	1,063
Year 15	2015	5,742	1,049	8	25	30	1,112	75	1,187
Year 16	2016	6,533	1,070	7	25	30	1,132	75	1,207
Year 17	2017	5,866	966	8	25	30	1,029	75	1,104

[a] Tier II, Resident, and Nonresident hunting allowed; General moose season shortened by 10 days to 1–20 September. Tier II dates changed to 15–31 August.

[b] Tier II and Resident hunting allowed; General bag limit changed from minimum of 3 brow tines to 4; nonresident moose hunting opportunities eliminated.

[c] Tier II hunt canceled; Draw hunts for residents (any bull) and nonresidents (50" or four brow tines) implemented; Ahtna Community Harvest hunt implemented for up to 100 any-bulls.

[d] Community Harvest hunt suspended; early 15–25 August season open to all Alaska residents for this year only.

[e] Community Subsistence Hunt implemented, eligibility open to any group of Alaska residents numbering 25 or more.

Antlerless harvest may be warranted to slow, stop, or reverse population growth as well as to help adjust bull:cow ratios but not until the population reaches the upper objective or a decline in moose nutritional status is observed. If the population reaches the upper objective and the mid-point of harvest objectives is not met, conservative cow hunts can be considered while promoting continued population growth.

Twinning rates are a sensitive indicator of nutritional status (Boertje et al. 2009) and have been monitored within Unit 13B and 13E. If the 2-year average twinning rate is >20% we will continue to promote growth. At a rate of 15–20% the population will be stabilized through harvest. If the 2–year average twinning rate is <15% the number of moose will be reduced through harvest. Predation control will be suspended if harvest alone is insufficient to stabilize or reduce moose numbers.

II. Anticipated Responses to Treatments

A. *Predator Abundance:*

The pre-control population estimate of 230–250 for wolves in Unit 13 was compiled from sealing records; trapper and pilot observations; and previous surveys. In early February 2015 an attempt to obtain a minimum count of wolves in Unit 13D and Unit 13E detected a minimum of 27 and 28 wolves for each unit respectively. The minimum counts, combined with observations and sealing records, were used to develop an estimate of 84 wolves for Unit 13. If this estimate is accurate then the objective to reduce the population to 60–70% of the pre-control population was not only been achieved, but surpassed. Further evaluation of the effectiveness of the wolf control program and assessment of wolf abundance will be derived from minimum count reconnaissance surveys or a Sample Unit Probability Estimator (SUPE) (Becker et al. 2004) when survey conditions are appropriate.

It is anticipated that wolf numbers would recover to pre-control levels in 3–5 years after control efforts cease through immigration and productivity (National Research Council 1997:52–53). The fluid nature of undefended wolf territories and the potential increase in moose abundance also could increase the rate of wolf immigration into the control area.

B. *Predation Rate:*

We will continue to monitor summer survival as well as overwinter survival of moose calves. Annual spring twinning, fall composition, and population surveys will be attempted annually to further determine the efficacy of the IM program. If a 60–70% reduction in wolf abundance is achieved (relative to pre-treatment abundance), we anticipate calf survival during the first 6 weeks of life would improve. Thus, if we observe no other increases in sources of other calf mortality, we expect to see higher numbers of calves relative to cows in fall composition surveys.

C. *Prey Abundance:*

Population trends for moose in Unit 13 are monitored by observing changes in the number

of moose observed in established trend count areas (CA) on an annual basis (Figure 2; Table 4). The number of moose counted in the continuous trend count areas declined through the 1990s and reached a low in 2002. When all continuous trend count data were combined in 2002, the observed unit-wide moose density averaged 1.0 moose/mi^2, with individual count areas ranging 0.5–1.2 moose/mi^2. Due to a combination of predation control, mild winters, and more conservative hunting regulations, the population began to increase steadily.

Within the core area of the predator control program, increases in moose numbers have been clearly evident through 2011. From the Alphabet Hills north through the Upper Tangle Lakes and Gulkana River (CA 5), the number of moose observed increased from 1,051 to 1,719 (64%) between 2002 and 2011. For the foothills of the eastern Talkeetna Mountains in subunit 13A (CA13 and CA14), the number of moose observed increased 86% from 917 to 1,705 during the same period. Observed unit-wide moose density within continuous count areas reached 1.4 moose/mi^2 in 2009 and further increased to 1.6 moose/mi^2 in 2011. For those areas completely within the predation control area, the density averaged 1.5 moose/mi^2 in 2009 and increased to 1.7 moose/mi^2 in 2011. While these data are from trend counts, and some movement is captured annually, these increases were relatively consistent over time. The increase in the moose density appeared to plateau by 2015, when the density averaged 1.5 moose/mi^2 in the continuous count areas within the predation control area.

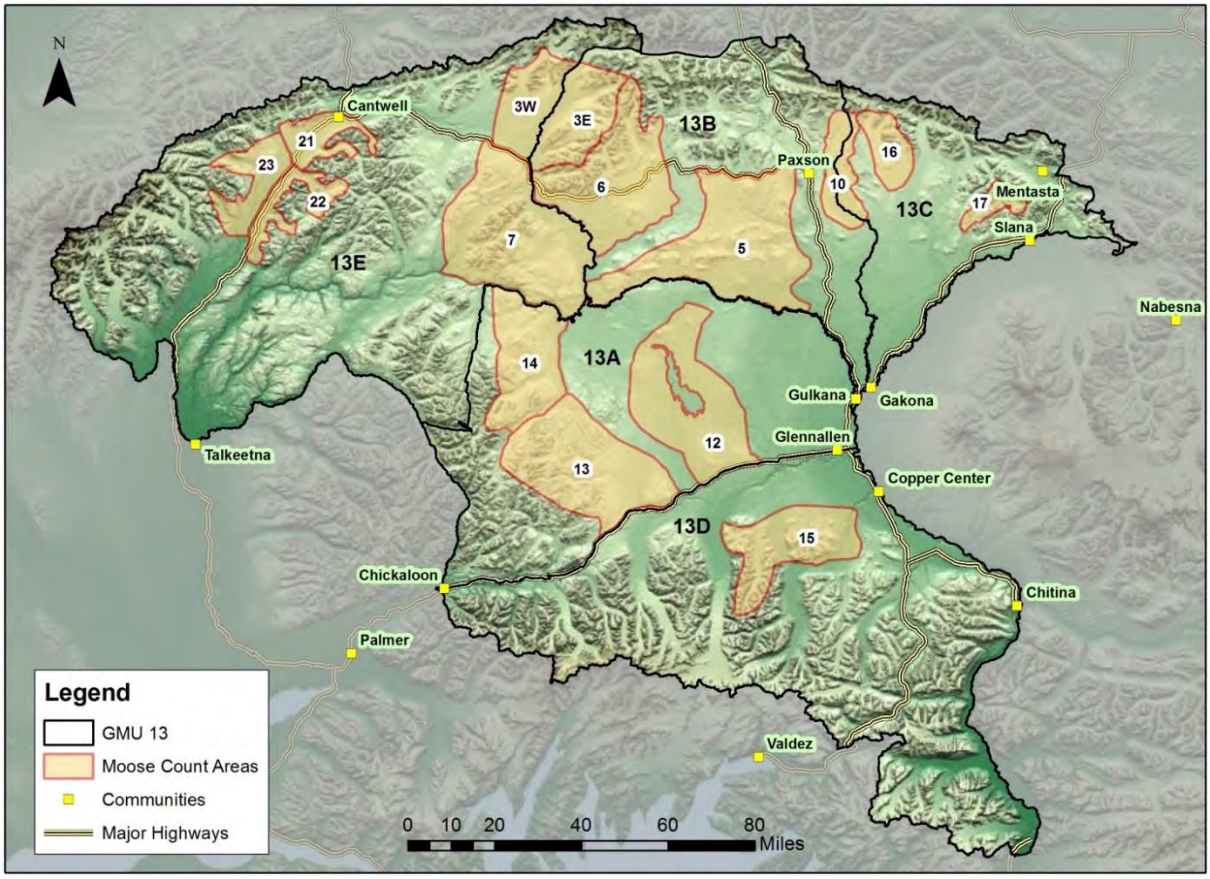

Figure 2. Distribution of count areas (CAs) used to estimate moose abundance in Unit 13.

Table 4. Unit 13 moose population estimates and composition.

Period	Year	Bull:100 Cows ratio	Calf:100 Cows ratio	Estimated abundance*
Year 1	2001	21	25	14,988
Year 5	2005	25	19	15,380
Year 6	2006	29	24	15,636
Year 7	2007	31	22	16,968
Year 8	2008	35	19	17,040
Year 9	2009	33	24	18,812
Year 10	2010	31	22	19,720
Year 11	2011	32	23	20,429
Year 12	2012	32	16	20,575
Year 13	2013	34	27	20,634
Year 14	2014	35	16	20,492
Year 15	2015	32	25	21,087
Year 16	2016	32	19	20,566
Year 17	2017	28	27	17,621

*Abundance estimates were reevaluated in 2015 to take advantage of modern mapping technology and provide a more accurate extrapolation based on annual survey data.

We anticipate the moose population to increase the most in areas where the proportion of predator removal is greatest. The anticipated increases in abundance will be utilized and regulated commensurate with increases in moose calf survival and recruitment.

C. *Prey Recruitment:*

If the wolf population is significantly reduced, we would anticipate a reduction in wolf predation on moose and an increase in moose survival. The reduction would lead to increased recruitment of calves into the yearling age class and an increase in moose abundance. We will continue to conduct productivity and survival flights using telemetry in May through the first few weeks of life, at 6 months of age, and in late winter to determine survival of known animals.

D. *Prey Productivity or Nutritional Condition:*

Moose productivity, twinning rates and over-winter and summer calf survival will be monitored as part of this plan. With collared females and an increase in moose densities we should be able to obtain sufficient sample sizes to monitor twining rates within Unit 13. If the 2–year average twinning rate is >20% we will continue to promote growth. At a rate of 15–20% the population will be stabilized through harvest. If the 2–year average twinning rate is <15% the number of moose will be reduced through harvest. Any

declining trend in twinning rate or other index of nutritional status will also trigger the department to re-evaluate population and harvest objectives. Predation control will be suspended if harvest alone is insufficient to stabilize or reduce abundance.

In addition, we continue to conduct habitat and browse utilization surveys (Seaton *et al.* 2011) across Unit 13. Any declining trend in browse availability will trigger a department proposal to re-evaluate the moose population and harvest objectives.

F. *Harvest:*

Predation control in Unit 13 will focus on reallocating the moose resource from wolf predation to human harvest. If wolf reduction is consistent and at a high enough level, an increase in the harvestable surplus of moose could result. Moose harvest is currently regulated under general harvest for bulls with spike-fork antlers or 50-inch antlers or antlers with four or more brow tines in Unit 13. There are additional opportunities to harvest any bull moose through drawing and the Community Subsistence Harvest (CSH) hunt. As the harvestable surplus increases additional opportunities will be provided.

G. *Other Mortality Factors:*

Evidence suggests that snow approaching chest height (Coady 1974) and deep snow years in excess of 31 in. (Keech 2012) severely limit movement and can be a factor that may lower recruitment and survival. Winter snow conditions in Unit 13 have been monitored by measuring snow depths at 17 established Natural Resources Conservation Service (NRCS) snow stations throughout the area from which a winter severity assessment is calculated. Severe winters have been reported in Unit 13 during the 1990s, 2000, 2004, 2011, and 2017. Observations of winter mortality over the years have suggested that moose mortality due to deep snow conditions has not been density dependent. Instead, there appears to be a threshold effect triggering increased calf mortality once snow accumulation approaches 30 inches. Reduced wolf densities may increase this threshold above 30 inches.

III. Evaluation Criteria and Study Design to Document Treatment Response

Adaptive management with the intent to increase harvestable surplus of prey requires evaluating the biological response and achievable harvest after treatments are implemented. Evaluation will be reported to BOG on 1 February each year with an interim update of selected criteria on 1 August each year.

A. *Predator Abundance and Potential for Return to Pre-treatment Abundance:*

The pre-control wolf population estimate of 230 to 250 wolves was calculated using sealing records, trapper and pilot observations, and previous surveys. This estimate forms the basis for the requirement that 135–165 wolves remain in the assessment area.

The department anticipates conducting a SUPE (Becker *et al.* 2004) when possible, to obtain an estimate of wolf abundance with precision. If conditions are not favorable to

conduct a SUPE the department will conduct minimum aerial counts combined with sealing records, trapper and pilot observations to evaluate whether continued aerial wolf control by the public each winter can achieve both wolf and moose population objectives.

B. *Habitat and Forage Condition:*

Habitat was not identified as a factor limiting moose productivity and recruitment, therefore baseline habitat or browse utilization assessments were not conducted at the plan's inception. We will be assessing current annual growth and browse removal which is identified as a measure of competition for food by moose that is inversely correlated to nutritional condition (Seaton *et al.* 2011). If significant declines in twinning rates are detected we will expand browse assessment studies.

C. *Prey Abundance, Age-sex Composition, and Nutritional Condition:*

The abundance objective in the Unit 13 assessment area is 17,000–21,400 moose. Age-sex composition will be assessed annually through GSPE surveys or trend count composition surveys as funding and weather permit.

The nutritional condition of moose will be monitored through twining rates using radio-collared females in the spring and from composition data derived from annual surveys. Currently 50 cow moose are collared in Units 13B and 40 in 13E. We will continue to maintain a collared portion of the population as funding allows.

D. *Prey Harvest:*

The moose harvest objective in Unit 13 is 1,050–2,180 with an Amount Necessary for Subsistence (ANS) of 300–600 moose. Moose harvest is monitored through moose harvest reports. Average reported harvest in the assessment area between 2013 and 2017 was 950 moose.

IV. Decision Framework to Implement or Suspend a Treatment

A. *Predation Control:*

The decision framework to evaluate, suspend, or terminate predation control will be based on achieving both predator and prey population and harvest objectives as follows:

- When the mid-point of intensive management objectives for the moose population are reliably achieved;
- When wolf inventories or accumulated information from permittees indicate the need to avoid reducing wolf numbers below the management objective of 135 wolves;

- If after 3 years the harvest of wolves is not sufficient to make progress towards the intensive management objectives for wolves;

Predation control activities may be terminated:

- If after 3 years, there is no detectable increase in the total number of moose in the control area;
- If after 3 years, any measure consistent with significant levels of nutritional stress in the moose population are identified;
- When moose population and harvest objectives within the Unit 13 predation control area have been met.

B. *Habitat Enhancement:*

1. For moose, if twinning rates fall below 20%, we will consider landscape-scale habitat manipulations, such as actively working with landowners to change fire management options or conduct prescribed burns to enhance nutrition for long-term maintenance of productivity.

2. For moose, if twinning rates fall below 20%, consider stand-scale treatments such as aspen harvest or willow crushing to attract moose to accessible sites for enhanced harvest with the goal of reducing local moose density.

No habitat enhancement projects are planned as a component of this operational plan other than evaluating and recommending fire management strategies that are consistent with population and harvest objectives. In addition, the department will conduct periodic forage assessments studies to evaluate the IM moose population objectives. If significant declines in forage availability and moose twinning rates are detected, habitat enhancement projects will be considered, and re-evaluation of population and harvest objectives will occur through department generated proposals.

C. *Prey Harvest Strategy:*

1. Prey Harvest.

Season and bag limit restrictions over the course of IM have maintained bull:cow ratios at or above objectives. Currently there is a general hunt for bulls September 1–September 20 (spike-fork antlers or 50-inch or antlers with four or more brow tines on at least one side), one "any bull" draw hunt (DM324: September 1–September 20; one antlerless draw hunt (DM325: October 1–October 31 and March 1–March 31); 5 nonresident draw hunts (DM335–339: September 1–September 20, 50-inch or antlers with 4 or more brow tines on at least one side); and the Community Subsistence Harvest Hunt (CM300: Unit 13 August 20–September 20, Unit 11 August 10–September 20, up to 100 "any bulls").

As abundance and sex ratios increase, additional harvest opportunities will be proposed to the Board of Game by the department. If harvest of female moose is needed to achieve population objectives, but not acceptable to users, IM treatments will be discontinued.

2. Prey Nutritional Index.

Calf productivity and survival will be monitored with particular attention to twinning rates as an important indicator of nutritional status. Declining trends in nutritional indices will trigger department proposals to re-evaluate population and harvest objectives relative to IM treatments. Declining trends in nutritional status will also trigger suspension of predator control if hunters are unable to harvest surplus animals.

V. PUBLIC INVOLVEMENT

A. *Continued Outreach by Department:*

Outreach is accomplished through state fish and game advisory committees (AC), and the board. Three of the 4 local advisory committees within Unit 13 (Copper Basin, Denali, and Paxson) are currently active. While the Tok Cutoff AC is currently inactive, the department will continue to encourage involvement from all committees within Unit 13.

B. *Continued Engagement to Confirm Criteria Chosen for Evaluating Success:*

We will continue to engage the advisory committees, the board, and department staff to evaluate the success of this program. The main objective of this operational plan is to increase moose harvest in the Unit 13.

C. *Participation in Prey and Predator Harvest or Predator Control:*

The public has participated in aerial wolf control through permits issued by the department, and wolf reductions have been effective. Local hunters and trappers will be encouraged to continue harvesting wolves and bears through the liberalized seasons and bag limits.

D. *Monitoring and Mitigation of Hunting Conflict:*

Advisory committee and board processes will be used to monitor and mitigate user conflict. Communication between committees and other stakeholders will be encouraged. Harvest reporting by all hunters will provide the Department with critical information on resource demand and harvest success.

LITERATURE CITED

ADF&G (ALASKA DEPARTMENT OF FISH AND GAME). 2011. Intensive management protocol. Juneau, Alaska. http://www.adfg.alaska.gov/static/home/about/management/wildlifemanagement/intensivemanagement/pdfs/intensive_management_protocol.pdf (Accessed 20 December 2011).

BALLARD, W. B., J. S. Whitman, and C. L. Gardner. 1987. Ecology of an exploited wolf population in Southcentral Alaska. Wildlife Monographs 98: 3–54.

BECKER, E. F., H. F. GOLDEN, AND C. L. GARDNER. 2004. Using probability sampling of animal tracks in snow to estimate population size. Pages 248–270 *in* W. L. Thompson, editor

BOERTJE, R. D., A. KEECH, D.D. YOUNG, K.A. KELLIE AND C.T. SEATON. 2009. Managing for elevated yield of moose in interior Alaska. Journal of Wildlife Management 73:314–327.

COADY, J.W. Influence of snow on the behavior of moose. Naturaliste Canadien 101:417–436.

GASAWAY, W. C., R. O. STEPHENSON, J. L. DAVIS, P. E. K. SHEPHERD, AND O. E. BURRIS. 1983. Interrelationships of wolves, prey, and man in Interior Alaska. Wildlife Monographs 84.

MCNAY, M.E. 1993. Evaluation and standardization of techniques for estimating wolf numbers in Interior and Arctic Alaska. Alaska Department of Fish and Game, Division of Wildlife Conservation, Research Final Report 1 July1992–30 June 1993, Federal Aid in Wildlife Restoration Study 14.15, Juneau.

KELLYHOUSE, R. A. 2006. Unit 13 wolf management report. Pages 90–99 in P. Harper, editor. Wolf management report of survey and inventory activities 1 July 2002–30 June 2005. Alaska Department of Fish and Game. Project 14.0 Juneau, Alaska.

NATIONAL RESEARCH COUNCIL. 1997. Wolves, bears, and their prey in Alaska: Biological and social challenges in wildlife management. National Academy Press, Washington, D.C.

SEATON, C.T., T.F. PARAGI, R.D. BOERTJE, K. KIELLAND, S. DUBOIS AND C.L. FLEENER. 2011. Browse biomass removal and nutritional condition of moose, Alces alces. Wildlife Biology 17:55–66.

TOBEY, R. W. 2003. Unit 13 wolf management report. Pages 91–98 in C. Healy, editor. Wolf management report of survey and inventory activities 1 July 1999–30 June 2002. Alaska Department of Fish and Game. Juneau, Alaska.

APPENDIX A. Summary of supporting information.

<table>
<tr><td colspan="2">Geographic Area and Land Status</td></tr>
<tr><td>Management area(s)</td><td>Prey abundance assessment (5,365 mi^2), prey harvest assessment (23,367mi^2), predator abundance assessment (23,367 mi^2), predator control (14,188 mi^2) – see Figure 1.</td></tr>
<tr><td>Land status</td><td>All lands within Units 13(A), 13(B), 13 (C), and that portion of Unit 13 E east of the Alaskan Railroad, except National Park Service and other federal lands where same-day-airborne take of wildlife is not allowed.</td></tr>
<tr><td colspan="2">Biological and Management Situation</td></tr>
<tr><td>Prey population</td><td>
<table>
<tr><th>Subunit</th><th>IM Population Objective (midpoint)</th><th>2017 Moose Population Estimate[a]</th><th>Percent Recovery to Objective Midpoint</th></tr>
<tr><td>GMU 13(A)</td><td>3,500–4,200 (3,850)</td><td>3,445</td><td>89%</td></tr>
<tr><td>GMU 13(B)</td><td>5,300–6,300 (5,800)</td><td>4,111</td><td>71%</td></tr>
<tr><td>GMU 13(C)</td><td>2,000–3,000 (2,500)</td><td>2,390</td><td>96%</td></tr>
<tr><td>GMU 13(D)</td><td>1,200–1,900 (1,550)</td><td>1,350</td><td>87%</td></tr>
<tr><td>GMU 13(E)</td><td>5,000–6,000 (5,500)</td><td>6,324</td><td>115%</td></tr>
</table>
</td></tr>
<tr><td>Prey harvest (human use)</td><td>Amount necessary for subsistence in Unit 13 300–600 moose.
<table>
<tr><th>Subunit</th><th>Moose Harvest Objective</th><th>Reported Harvest in 2017</th></tr>
<tr><td>GMU 13(A)</td><td>210–420</td><td>323</td></tr>
<tr><td>GMU 13(B)</td><td>310–620</td><td>280</td></tr>
<tr><td>GMU 13(C)</td><td>155–350</td><td>88</td></tr>
<tr><td>GMU 13(D)</td><td>75–190</td><td>90</td></tr>
<tr><td>GMU 13(E)</td><td>300–600</td><td>197</td></tr>
</table>
</td></tr>
</table>

Feasibility of access for harvest	Access for harvest exists via the highway system by boat, all-terrain vehicles (ATV), and snowmachines. Airplanes can access the area through a few water bodies and airstrips.
Nutritional condition	Habitat is not limiting based on twinning rates. Estimates of twinning rates from radio-collared moose in 2015 were 20% in Unit 13B and 46% in northwest Unit 13. In 2017 a twinning rate of 59% was estimated for radio-collard cows in Unit 13B.
Habitat status and enhancement potential	The only recent large-scale habitat improvement project that has occurred in Unit 13 is the 41,000 acre[2] Alphabet Hills Prescribed Burn in 2003 and 2004 on the border of Unit 13(A) and 13(B). Further burning under this plan is still being pursued, though it is contingent upon meeting burn prescriptions and having available suppression resources.
Predator(s) abundance	Wolf estimate in spring 2018: 250 wolves
Predator(s) harvest	Wolf harvest in 2017: 89 wolves.
Evidence of predation effects	During the fall of 1999 and 2000, Unit 13 wolf abundance estimates peaked at more than 500 wolves. The number of moose observed during trend counts declined by 47% between 1987 and 2001. Moose across the Unit 13 treatment area have generally increased since IM program inception, (52% unit-wide increase in moose between 2001–2010) with numbers of cows peaking in 2012. Between 2012 and 2013, cow numbers increased further in Unit 13A. Observed bull numbers increased substantially during the early years of the program. The Unit 13 IM program has been inactive since 2014 and estimates of moose abundance have declined since 2016.
Feasibility of predation control	Wolf population objectives were met six of eight years between 2005 and 2012, and the moose population increased towards the objectives. It is anticipated that the moose harvest objective may only be achieved with sufficient liberalizations of antlerless moose hunting opportunity.
Other mortality	Severe winters have been documented as recent as 2017. During the years 2010–2014 an average of 27 moose were reported struck by trains in Unit 13E.