OPERATIONAL PLAN FOR INTENSIVE MANAGEMENT OF MOOSE IN GAME MANAGEMENT UNIT 24(B) DURING REGULATORY YEARS 2012–2017

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 (Title 5 Alaska Administrative Code, Section 92, Part 125; abbreviated as 5 AAC 92.125) for moose in Game Management Unit 24(B) during Regulatory Years (RYs) 2012-2017. It describes rationale for evidence of limiting factors; choice of indices for evaluating treatment response; and decision frameworks for predation control, habitat enhancement, and prey harvest strategies. The *Intensive Management Protocol* (ADF&G 2011*a*) contains further description of administrative procedures and the factors and strategies in adaptive management of predator-prey systems to produce and sustain elevated harvests of caribou, deer, or moose in selected areas of Alaska. The IM plan for moose in Unit 24(B) has been developed based on the recommendation of Koyukuk River Fish and Game Advisory Committee and at the request of the Alaska Board of Game (BOG). The IM plan and this operational plan include information and recommendations from a Feasibility Assessment prepared by ADF&G (2011*b*) (summary of supporting information in Appendix A) and recommendations by the BOG following public comment at the March 2011 BOG meeting. **This is an experimental treatment to evaluate whether (a) wolf control in a focused area can allow reallocation of moose mortality from predators to humans and (b) whether moose harvest per unit effort is a feasible response metric at low moose density.**

BACKGROUND

Moose occur at low density in Unit 24(B), and the current population estimate is below the IM population objective established in 2006. Residents in the Upper Koyukuk River Drainage in Unit 24(B) (Fig. 1) have experienced difficult moose hunting for many years, due to the low density of moose in the area. The difficulty in obtaining a moose has been compounded by increasing fuel prices. Baseline biological data were collected in Unit 24(B) since 1989 (Appendix B), and those data corroborate the moose population estimates and the concerns of local subsistence hunters. The Department has assessed the moose population in Unit 24(B), and has developed an IM Plan to address the unique situation for this area.

An Upper Koyukuk Management Area (UKMA) is established within Unit 24(B) by the IM plan, surrounding the villages of Alatna and Allakaket. The UKMA overlaps a portion of the Kanuti National Wildlife Refuge (NWR) (Fig. 2), and moose surveys conducted in the unit were focused on the refuge, but some years those surveys also included lands in the remainder of Unit 24(B) and Gates of the Arctic National Park and Preserve. Population estimation survey density on the Kanuti NWR was 0.67 moose/mi^2 in 1993, but was stable and averaged 0.33 moose/mi^2 during 1999 to 2011 (Fig. 3). Moose density on the refuge and the remainder of Unit 24(B), likely followed trends similar to those observed throughout the Galena Management Area and other regions in Alaska following the repeal of Land and Shoot wolf hunting regulations in 1991 (Regelin et al. 2005). The moose population now appears to be stable at low density with small annual fluctuations. Subsistence Division household surveys in Alatna/Allakaket estimated harvest was nearly 40 moose/year in 1997-2002 (Anderson et al. 2000, Brown et al. 2004), while total estimated harvest among all hunters in Unit 24(B) was 83-109 moose (RY07-RY09; Stout 2010). Based on the 2010 estimated observable population of 2,600 moose and a harvest of 82 moose, the harvest rate was 3.2%, which was below the management objective harvest rate of 5% [24(B) IM objectives; population = 4,000-4,500, harvest = 150-250]. Harvest of wolves,

black bears, and grizzly bears is low (20-30 wolves/year, 20-30 black bears/year, 3-8 grizzly bears/year).

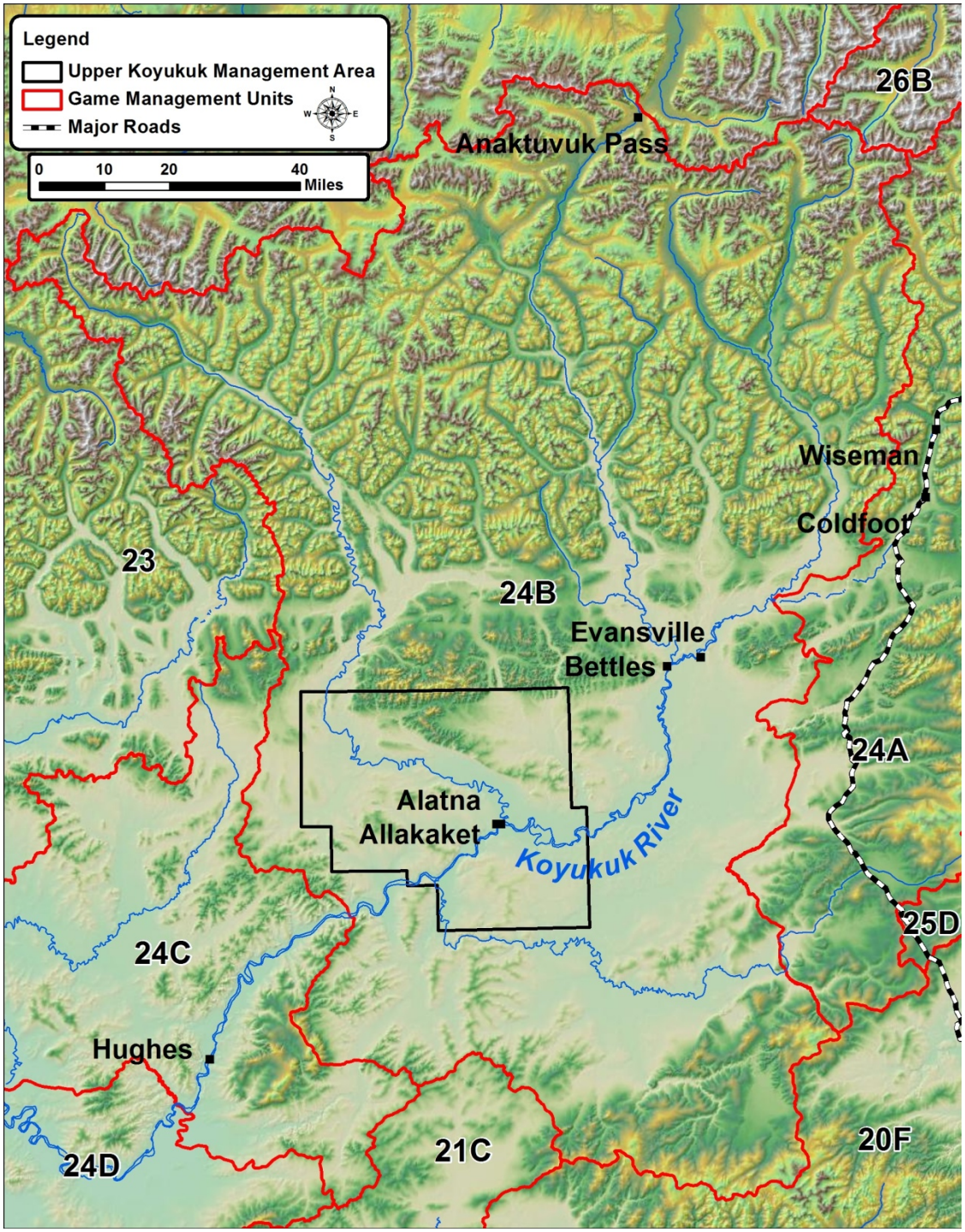

Figure 1. Upper Koyukuk Management Area (1,360 mi^2) in Game Management Unit 24(B) (13,523 mi^2).

Habitat in the UKMA is excellent as demonstrated by the high twinning rates (avg. = 57%; 2008-2011) with low browse utilization in 2007 (browse biomass removal = 5.3%, removal index = 8.8%). High fire frequency in Unit 24(B) has resulted in a high proportion of early seral vegetation communities; however, relatively few fires of significant size have occurred within the UKMA portion of Unit 24(B) in the last 30 years, due to fire suppression activities and other factors. Winters are marked by severe cold weather, but winters with deep snow (>36 in) likely to influence moose habitat selection or cause high energy use occurred in only 9 of the last 20 years.

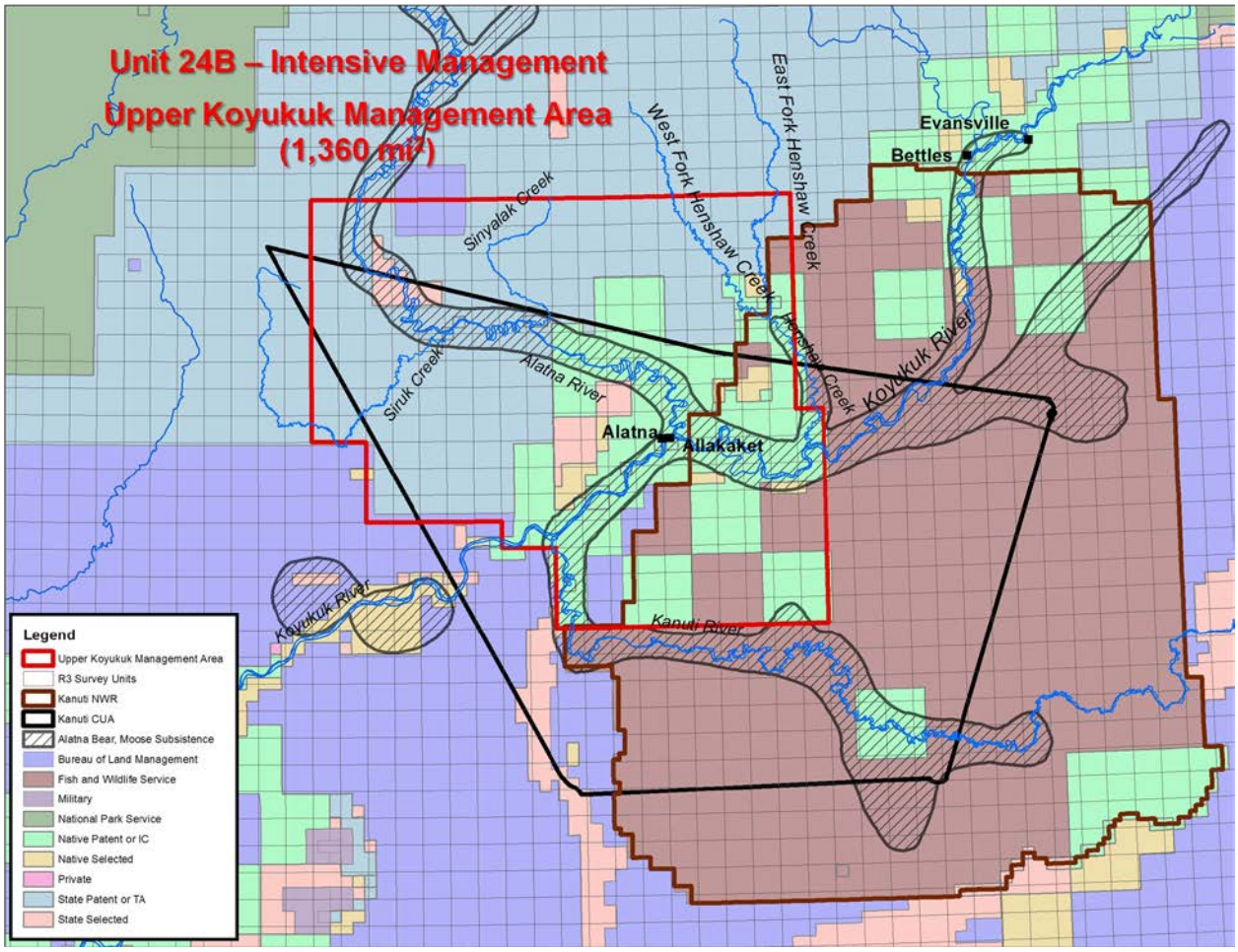

Figure 2. Land ownership and Subsistence resource use patterns within the Upper Koyukuk Management Area of Unit 24(B).

Federal and state hunting regulations in Unit 24(B) are liberal and mostly overlapping, with a small difference in Controlled Use Area boundary. The Kanuti Controlled Use Area prohibits the use of aircraft for moose hunting under state and federal regulations. Federal lands within the federal Kanuti Controlled Use Area boundary are closed to hunters who are not federally qualified. The state and federal fall moose season runs 38 days in August and September, and a winter bull season runs from December 15th to April 15th (122 days).

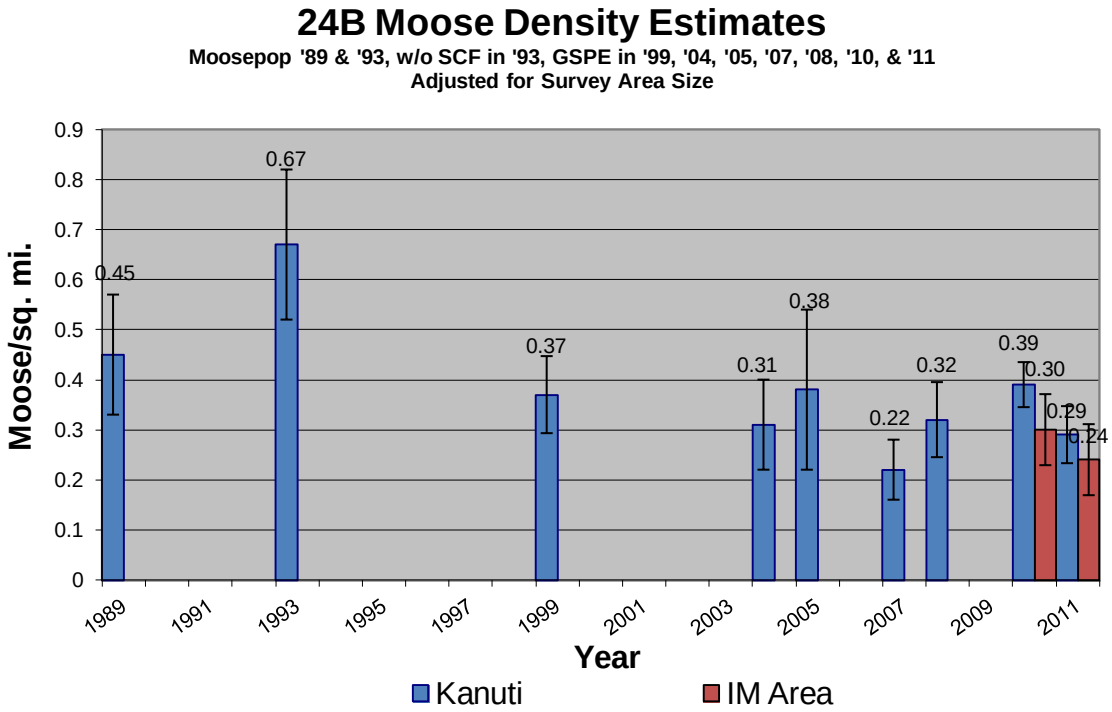

Figure 3. Population estimates on the Kanuti National Wildlife Refuge and Upper Koyukuk Management Area in Unit 24(B), 1989-2010.

This proposed IM plan contains several components that are tailored to the unique biological and cultural issues inherent to Unit 24(B): 1) black and grizzly bears are likely the primary mortality factor effecting calf survival based on composition data and field studies in adjacent Game Management Units (GMU's) (21D & 24D), but they will not be included in predator control activities; 2) local resident cultural taboos make bear control an untenable option; 3) the scope of the program will be small in terms of area and wildlife populations affected; 4) the treatment area is nested within tracts of USFWS land but predation control will not occur on those lands; 5) IM treatment response monitoring will be limited to the inventory activities of the current management program, a calf (> 6 mo. old) and yearling survival rate study, and household subsistence harvest surveys; 6) the current population and harvest estimates are below the Unit 24(B) IM objectives (5 AAC 92.108; Appendix A), and the department anticipates that the IM Population Objectives will not be achieved due to the limited scope of this proposed program; and 7) the department will prioritize efficiency and cost effectiveness in implementation of the program.

This operational plan describes an experimental approach to adaptive management that will test predation control in a relatively small area on a low density moose population. The intent of this IM program will be to increase moose for harvest primarily by residents of Alatna and Allakaket using a cost efficient predation control strategy that could potentially be conducted near other rural communities in Alaska where similar moose harvest concerns exist. Evaluation of subsistence user harvest as a metric for predation control effectiveness will be an important element of this adaptive management program.

The scope of this experimental program is limited in its expected impact on the wolf and moose populations. It is primarily a reallocation of moose from wolves to humans in a confined area and not expected to contribute substantially to a larger moose population or harvest in Unit 24(B). Much of the IM area is privately-owned Alaska Native corporation land, so the benefit of this program will most likely accrue to the local residents of Allakaket and Alatna unless surviving moose move outside the treatment area. However, it may reduce competition for moose hunting on adjacent lands.

ADAPTIVE MANAGEMENT FRAMEWORK

Any section of this 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:*

Based on fall moose composition data in 24(B) (Stout 2010) and previous moose mortality studies in the Interior (Osborne et al. 1991, Boertje et al. 2009), we expect that black bears and grizzly bears contribute to the largest proportion of mortality among moose calves < 6 months old, whereas wolves are the primary predator on calves > 6 months old and yearling moose. However, only wolf numbers will be reduced in the UKMA as a component of this predation control program, for the following reasons; 1) lethal bear removal is unacceptable culturally to local publics, 2) non-lethal bear removal is cost-prohibitive and unacceptable culturally to the local public, 3) population modeling suggests an increase of 190-210 moose within the UKMA can may be achieved by 2017 through wolf control alone.

Aerial removal of wolves within the UKMA will utilize fixed-wing aircraft to locate wolves and Department staff in helicopters to lethally shoot wolves. Wolf removal will occur in early winter (October-December) to maximize calf/yearling winter survival. It will be conducted by Department staff as soon as snow cover conditions allow for suitable tracking by fixed-wing aircraft. To economize wolf search expenditures, wolves will be located during regularly scheduled fall moose surveys, as part of annual Survey and Inventory (S&I) management activities. Helicopter control activities will likely last 5-7 days, depending upon weather conditions. Follow-up efforts may be conducted if substantial wolf presence is detected during other management activities during the winter. Wolf control will begin in fall 2012 and will be conducted annually during winter over the course of the six year program. The department will have the discretion to adjust the size and shape of the UKVMA up to 20 percent (approximately 2,700 square miles) of Unit 24(B) if it becomes necessary for effective removal of wolves.

Public harvest of wolves and bears under current regulations will continue to be encouraged. Public aerial shooting permits for removal of wolves may be available to interested parties as authorized in 5 AAC 92.110 beginning fall 2012. Consideration will be given to continue public aerial shooting permits beyond the end of this study, in order to prolong the effect of this program. Harvest incentive programs for hunters and trappers that are initiated and funded by Alaska Native corporations will also be encouraged.

Wolf control within the UKMA will be restricted to state, U.S. Bureau of Land Management (BLM), and Alaska Native corporation lands. No wolves will be removed by aerial shooting on national wildlife refuge lands within the UKMA, or on National Park Service lands unless approved by the federal agencies if the UKVMA is expanded. However, wolves that incidentally travel from Refuge or Park Service lands onto state, BLM, or private lands within the UKMA during control activities will be subject to lethal removal.

B. *Habitat Enhancement:*

There are no habitat enhancement projects proposed in this plan. However, two management needs were identified that have the potential to positively affect moose within the UKMA: 1) work with land owners and managers in the area to liberalize fire management options so that wildfires have the potential to convert the vegetation communities to earlier seral stages, especially the spruce communities in the Alatna River drainage portion of the UKMA, 2) work with land owners to prescribe and conduct mechanical treatment of late seral vegetation communities along the riparian habitats, close to the villages of Alatna and Allakaket. Mechanical treatment near the villages could reduce fuels that carry wildland fire and have the additional benefit of reducing the need for large buffer zones delineated by the fire management options for the area.

C. *Prey Harvest:*

As previously described, moose densities in the area are low and the potential for achieving a detectable increase in moose density is low, due to the relatively small size of the UKMA treatment area within Unit 24(B). Subsequently, the potential for adverse impacts to habitat due to gradual population increases is also expected to be low, and the potential need for additional liberal harvest strategies is unlikely. However, because locals are the primary moose users in the area and because they favor antlerless moose harvest, either sex moose seasons will likely be implemented. As projected by this program strategy, once the first two cohorts of moose that benefited from treatment have been recruited into the population by the 2^{nd} to 3^{rd} year of wolf control, we would expect to be able to provide moose harvest of either sex. Either sex harvest under this experimental program is anticipated to occur early in the program because the concept of reallocation of the moose from wolves to people implies an immediate availability of moose if wolf numbers are reduced, and does not depend on measurable population growth to meet program objectives. Antlerless moose harvest should increase hunter success and would be expected to benefit program effectiveness evaluations. Final determination of the either sex seasons will likely be dependent upon observed improvements in survival rates of radio-collared calves (> 6 mo. old) and yearlings and improvement in calf:cow and yearling bull:cow ratios observed in aerial surveys. Because

wolf numbers are expected to rebound quickly following treatment (2-3 year lag), efficacy of either sex moose harvest would be reconsidered within 2-3 years after the end of wolf control efforts.

II. ANTICIPATED RESPONSES TO TREATMENTS

By removing approximately 90% of the estimated pre-control wolf abundance in the UKMA and maintaining that level (<6 wolves) for 5 winters (fall 2012-spring 2017), the PredPrey model (McNay and DeLong 1998) forecasted that the number of moose within the UKMA would increase from approximately 405 (±97) moose in 2011 (prior to wolf control) to 600 moose in 5 years (Figs. 4 and 5). Initial model input included moose harvest of 15 bulls and 5 cows and predator populations of 25 grizzly bears and 75 black bears (with objectives of 20 grizzly bears and 60 black bears at stable abundance). Optional prey of 5,000 caribou and 100 sheep with a maximum predation rate of 1% to account for intermittent occurrence within the area or potential prey sources that wolves may utilize near the area. Adult moose biomass was set at 856,488 lb/1,000 mi^2 (150,000 kg/1,000 km^2), and non-predator mortality rates were set at 5%, 2%, 6%, and 10% for adult males, adult females, yearlings and calves respectively. The actual moose population change within the UKMA is expected to be small (absolutely and relatively), thus may be difficult to detect at a relative precision of 25% at the 90% confidence level (Hayes et al. 2003). Nonetheless, it would represent an increase in the number of moose in the UKMA and will progress toward achieving the IM population objective for 24(B).

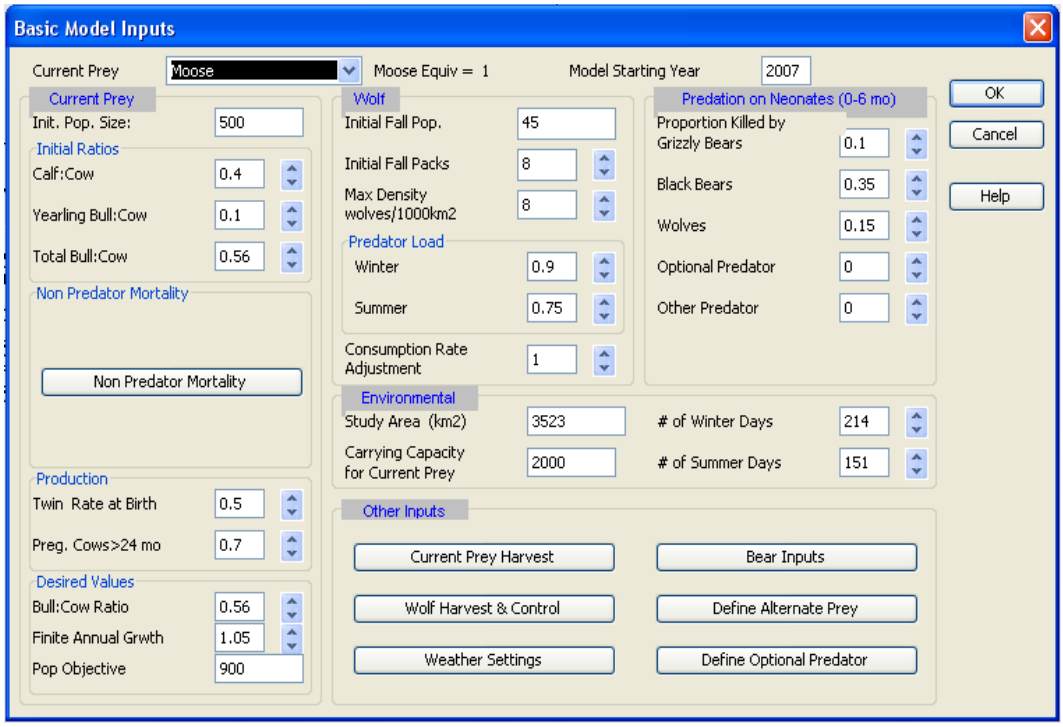

Figure 4. PredPrey Basic Model Input values menu for the Upper Koyukuk Management Area modeled population.

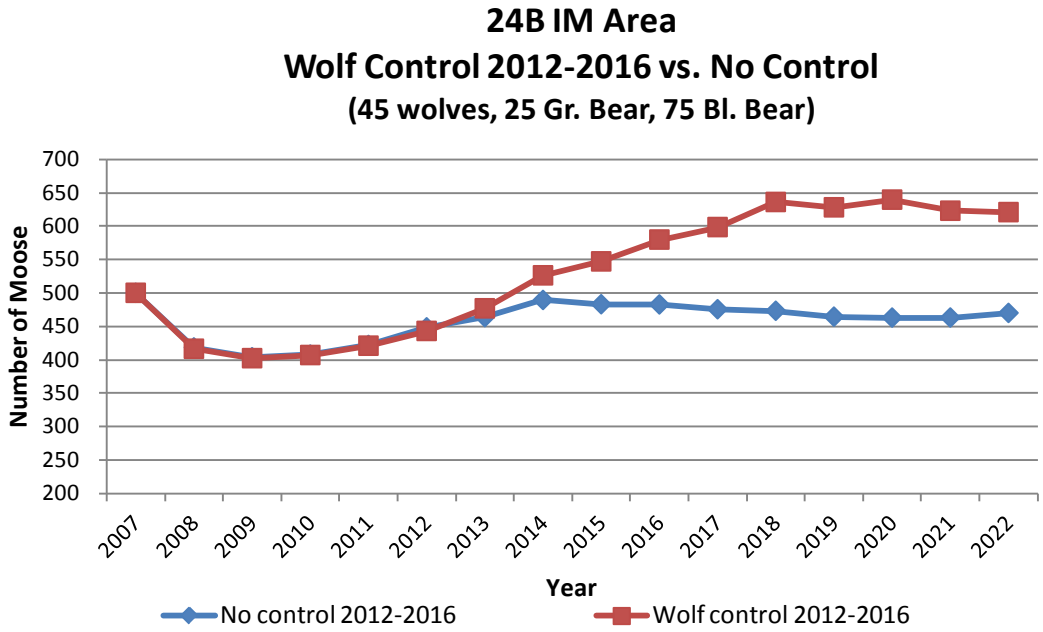

Figure 5. Forecasted moose population scenarios for the Upper Koyukuk Management Area with wolf control during RYs 2012-2016 (5 winters) and no wolf control. Model inputs and change in moose harvest are described in text. Lines are the average of ten iterations of the two modeled population scenarios.

A. *Predator Abundance:*

Within the UKMA (except national wildlife refuge lands), all wolves observed will be lethally removed for 5 winters, but we do not expect to observe every wolf because of conifer forest cover and other factors. Within the UKMA, pre-control wolf abundance was estimated to be 50-60 wolves from a survey conducted in March 2011, so we expect to remove up to 45-55 wolves in the first winter with an objective of maintaining fewer than 6 wolves in subsequent winters. We anticipate wolf recruitment (reproduction and immigration) of 15-25 wolves each following year, requiring lethal removal of at least an additional 10-20 wolves/year. In our 2008 assessment for wolf density in a larger portion of Unit 24(B), we estimated approximately 15-21 wolves/1,000 mi^2 (6-8 wolves/1,000 km^2), which is consistent with literature values for similar habitats and prey abundance (Adams et al. 2008, Stout 2009). That density would have predicted an average about 25 wolves in the UKMA. In the March 2011 survey, several of the wolf packs we observed were located near the perimeter of the UKMA, suggesting a density that was higher than previously estimated. Also, some packs in the March 2011 survey were estimated based on track counts. Modeling of the UKMA fit observed moose population values best when the wolf density input values for the UKMA were at 25-35 wolves. The small area of the UKMA relative to the size of the perimeter and the coincidental juxtaposition of packs in Unit 24(B) during the 2011 survey explain that relatively high estimate of the 2011 survey. Additionally, the influx of Western Arctic Caribou Herd animals during the 2011 survey may have influenced wolf abundance.

Change in the wolf population in Unit 24(B) caused by wolf control within the UKMA will likely not be detectable using standard survey methodology. The UKMA treatment area represents only 10.1% of the land area of Unit 24(B) (Figure 1). An evaluation of effectiveness of wolf control by the Department within the UKMA will be conducted at the end of the 5-year program. If the program is demonstrated to have been effective at increasing moose harvest or harvest per unit effort among local residents, the Department may evaluate using public aerial shooting to extend the benefits of localized predation control within the UKMA.

Elevated moose abundance and an absence of wolf packs defending territories within the UKMA could facilitate wolf immigration. However, numerical and functional responses of predators and prey in multiple prey and multiple predator systems are complex (Gasaway et al. 1992, Boertje et al. 1996, Boertje et al. 2009, Arthur and Prugh, 2010). Therefore, long-term assessment of the response of wolves and moose will provide new insight into population dynamics of a low density moose population.

The management objective for wolves in Unit 24(B) under the current S&I program, was to regulate the population at a 35% annual harvest rate. Based on a fall 2008 estimate of 202-284 wolves (15-21 wolves/1,000 mi^2), this allowed for a harvest of 70-100 wolves and a spring population of 130-180 wolves (9.6-13.3 wolves/1,000 mi^2) (Stout 2009). The management objective for wolf abundance in Unit 24(B) during the predation control program, will be a harvest rate of up to 50% of the fall population, which will allow for a harvest of 100-140 wolves and a spring population objective of 100-140 wolves (7.4-10.4 wolves/1,000 mi^2). Because up to 50-60 wolves could be removed from within the UKMA during predation control activities, this would allow for the harvest of 40-80 wolves in the remainder of Unit 24(B) by hunters and trappers. Harvest in Unit 24(B) is typically 20-30 wolves, therefore it is unlikely that the Unit 24(B) control objective will be achieved, even with wolf removal occurring in the UKMA. A population of 100-140 wolves in Unit 24(B) will assure that wolves persist as part of the natural ecosystem in Unit 24(B) and assure continued wolf hunting, trapping, and viewing opportunities.

B. *Predation Rate:*

Calf (> 6 mo. old) and yearling survival rates will be monitored using 30 radio-collars deployed on calves (> 6 mo. old) in the fall of each year of the program within the UKMA and an additional 30 moose in an area to the east that will serve as an experimental control (non-treatment area; Figure 6). The non-treatment area was selected based upon similar habitat and moose density characteristics and is separated from the UKMA treatment area by an 18.6 mi. (30km) buffer. The buffer between the UKMA and non-treatment areas was determined using observed pack locations and average home range polygons for wolf packs from surveys conducted on the Kanuti NWR and surrounding areas. Collared moose will be observed monthly to determine mortality rates, and mortality causes will be assessed when access is feasible. Moose surveys will also continue to be conducted under the regularly scheduled S&I program, and composition data will provide additional survival assessment data.

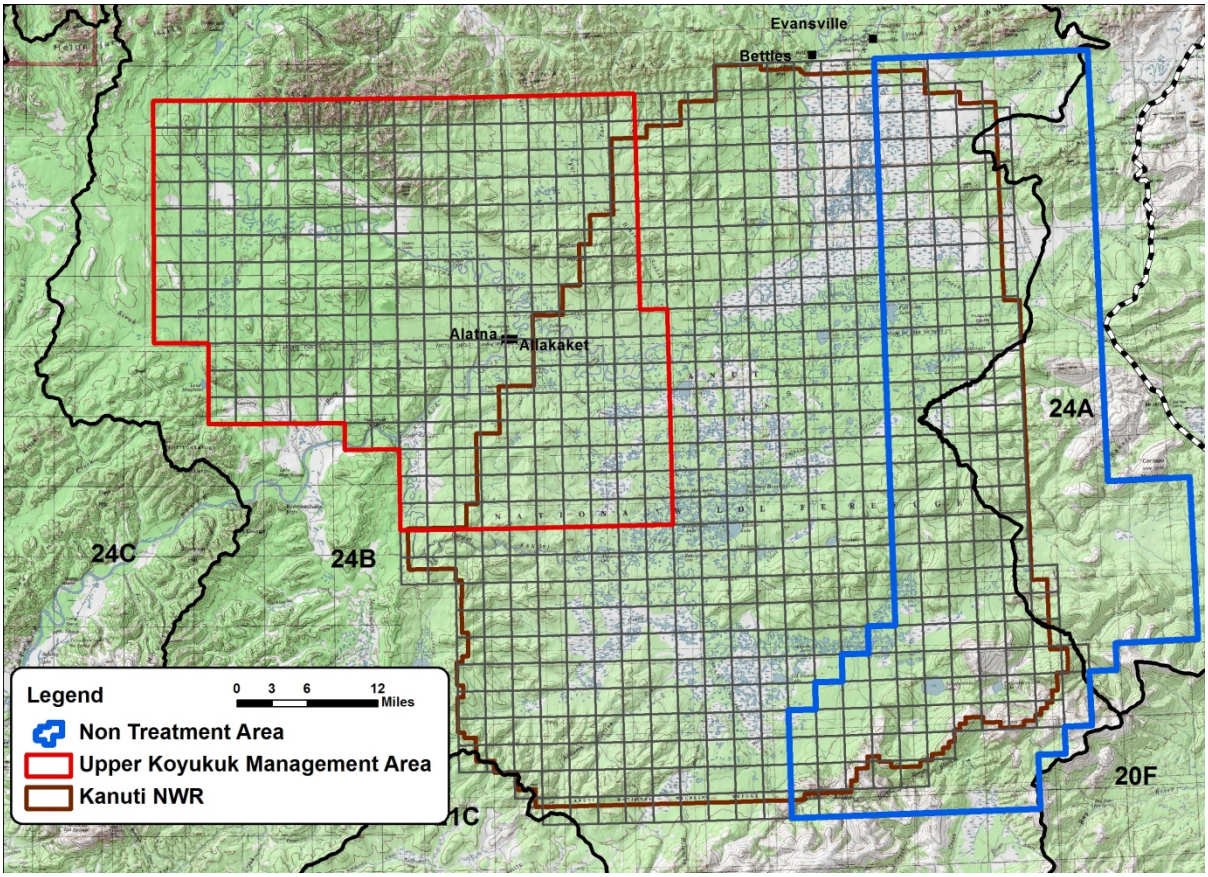

Figure 6. UKMA area and non-treatment experimental control area.

C. *Prey Abundance:*

The UKMA represents only 10.1% of Unit 24(B), and densities of moose and wolves within the game management unit are low. Our ability to detect change in moose abundance within the UKMA will be limited regardless of survey methodology. As mentioned previously, we expect the number of moose within the UKMA to increase from approximately 405 (±97) moose to 590-610 moose in 5 years. The Unit 24(B) population is expected to continue to be stable at intermediate population levels between current lower density (0.25-0.30 moose/mi^2) and historically higher densities (0.65-0.70 moose/mi^2). Additionally, low sample size associated with a low density and the relatively small treatment area may hinder use of composition data from GSPE surveys for detecting a statistically significant changes in calf:cow or yearling bull:cow ratios in the UKMA.

The duration in response of moose numbers within the UKMA will depend on initial response to wolf control and effectiveness of predator harvest by the public, including bears, following Department control efforts that end after winter 2016-17. If improved moose calf (> 6 mo. old) and yearling survival are demonstrated and improved hunter

success is realized, implementation or continuation of public aerial shooting of wolves could prolong the response of the initial predation control efforts. In the absence of continued wolf control, the population will likely continue to fluctuate at lower density typical of the last 3-5 years (Fig. 3) unless a proportional higher harvest of wolves occurs.

D. *Prey Recruitment:*

The wolf population survey in March 2011 estimated at up to 50-60 wolves in UKMA area (see section II. A.). Based on modeled wolf predation rates on moose, we expect wolf control to improve winter survival so that up to 65 additional calves (6 mo. old to 12 mo. old) and 30 yearlings (12 mo. old to 24 mo. old) will survive annually. Modeled ratios improved from 30 to 37 calves:100 cows and from 10 to 12 yearling bulls:100 cows.

E. *Prey Productivity or Nutritional Condition:*

Proportional removal of browse biomass from sampled plants in 2007 was 5.3% (95% CL: 4.3–6.3%, n = 231 shrubs) in Unit 24(B), which along with Unit 24C was the lowest measured to date in the Interior (Paragi et al. 2008). The removal index extrapolated to the shrub counts and species composition in Unit 24(B) was 8.8% (6.8–10.8%, n = 231 shrubs). The brooming index was relatively low for the Interior at 0.34 (95% CL: 0.28–0.40, *n* = 231 shrubs), and 51% of the plants had no evidence of past browsing by moose. With low browse use, a small increase in the number of moose unit-wide is not expected to have a measurable effect on habitat, even at moose density objectives of 0.65-0.70 moose/mi^2 within the UKMA.

Using adult radio-collared cow moose from a concurrent study in Units 24A and 24(B) and additional randomly located cows in that area, twinning rate surveys will continue to be conducted in late May or early June of each year. Because the moose population is not expected to change significantly in Game Management Unit 24(B), and because habitat conditions are not expected to be impacted, body condition and twinning rates are not expected to change significantly as a result of predation control.

F. *Harvest:*

Predation control in the UKMA will focus on reallocation of the moose resource from wolf predation to harvest. The reallocation of moose can be achieved with the removal of relatively few wolves (45-55 wolves in the 1st winter, 15-20 wolves in winters 2-5) within the UKMA portion of Unit 24(B). At that level of wolf control, the anticipated increase of 190-210 moose within the UKMA by year 5 is expected to improve hunter success and reduce hunting effort required to achieve that success. The realized increase in moose density is expected to improve moose encounter rates for hunters along the river

corridors. However, harvest may not simply increase by the number of moose not killed by wolves because it is uncertain how improved hunter encounter rates with moose are related to moose density. Because moose harvest in the villages of Alatna and Allakaket is modest (35-40 moose/year), we project a harvest rate of 6-8% of the 590-610 moose after 5 years of treatment will be realized by local hunters. However, a portion of that harvest may include harvest from lands adjacent to the UKMA, therefore the precise estimate of harvest rate is uncertain. Moose harvest will likely be a result of increased moose abundance as well as reallocation of moose from wolves to people.

Encounter rates and hunter success are dependent on a variety of factors each year (e.g. hunter effort, water level restrictions on boat travel, distribution of moose, etc.); therefore, an increase in moose density does not ensure a proportional increase in harvest. The projected increase in moose numbers would be similar to historical densities of 0.60 to 0.65 moose/mi^2, which corresponded to historical periods of higher harvest levels (Marcotte and Haynes 1985, Anderson et al. 2000, Brown et al. 2004, Stout 2010). Thus, we expect the projected increase in moose will provide for comparable levels of harvest demand in the villages of Alatna and Allakaket.

Subsistence Division conducted a household survey in the villages of Alatna and Allakaket in October 2011, prior to the initiation of program treatments to establish pre-treatment harvest levels. These surveys will occur each year following predation control efforts. Harvest and catch-per-unit-effort parameters will be monitored to assess treatment effect on harvest success. Although anticipated increases in harvest will not achieve Intensive Management Harvest Objectives for Unit 24(B) identified in 5 AAC 92.108, the improved harvest levels will represent progress toward achieving those objectives.

G. *Use of Nontreatment Comparisons:*

As previously described, an experimental control non-treatment area will be established in the eastern portion of Unit 24(B) with habitat and wildlife population characteristics comparable to the UKMA (Fig. 6). Moose population estimation surveys will continue to be conducted in the adjacent area of the Kanuti NWR.

H. *Other Mortality Factors:* None determined (see Feasibility Assessment). Blood assessment of moose radio-collared in 2007 showed low incidence of exposure to common diseases. Frequency of severe weather events is low. No die-offs have been reported.

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

(Walters 1986). Evaluation will be reported to BOG in February each year with an interim update of selected criteria in August each year.

A. *Predator Abundance and Potential for Recovery:*

An aerial wolf census (Gasaway et al. 1983) will be conducted in February-March of the 1st and 5th year of the program to assess wolf abundance within the UKMA and adjacent Kanuti NWR. A census was conducted in Unit 24(B) over previously surveyed portions of the UKMA and the Kanuti NWR, in March of 2011 as part of the regular S&I program, and wolf surveys conducted for the IM program will follow similar protocols (see Section II. A above). Wolf abundance will be monitored during the 2nd through 4th years of the study in the UKMA during control activities (Oct./Nov. and Feb./Mar.). The Unit 24(B) wolf population will be monitored during normal S&I activities (moose surveys, radio-tracking flights), conducted for the duration of the program. Bear abundance will not be monitored.

The objective of the wolf control program is to remove as many as practical within the UKMA during 5 consecutive winters. Visual concealment by vegetative cover, wolf travel patterns along the periphery of the control area, and other variables limit removal effectiveness, so we expect some wolves will still inhabit the area following control efforts. Increase in wolf abundance in the UKMA following a control program will depend in part on public harvest. Based on existing hunting and trapping patterns and historical re-population of wolves following the cessation of aerial hunting in the early 1990's in Unit 24 (Stout 2010) and other case histories (National Research Council 1997), wolves within the UKMA will likely return to pre-control abundance levels within 3-4 years even with harvest.

All wolves removed will be delivered to contracted skinners (see Section V. C below). Biological data will be collected from each wolf to include: 1) location of harvest and pack size, 2) sex, 3) body mass before skinning, 4) reproductive tract of females, 5) tooth for age estimation, and 6) blood sample (DNA archive and disease assessment).

B. *Habitat:*

No forage assessment studies are proposed for this program. If significant declines in twinning rates are detected, forage assessment studies will be considered.

C. *Prey Abundance, Herd Composition, and Nutritional Condition:*

Survival of moose during their first and second winters will be monitored using 30 radio-collars deployed in the fall of each year of the program on calves (5-6 mo. old) within the UKMA and 30 radio-collars within the non-treatment area. In the first year of the program, 15-20 collars will be deployed in March 2012 on ~9 mo. old calves in both

areas to evaluate the yearling cohort in the first year of predation control. If possible, moose calves will be captured using net-guns from helicopters in October and November, to reduce costs of immobilization drugs. Immobilization drugs delivered via projectile darts (more expensive) will be used if conditions do not allow for net-gun captures.

Collared moose will be relocated by fixed-wing aircraft 1 time each month during November to April to estimate mortality rates. Cause of mortality will be assessed from the air if possible and on the ground, when landing on skis is feasible. Collared moose will be relocated 2 times per month during May to October to improve potential for assessing mortality factors during months when carcass degradation is more rapid, but ground visits will likely be impractical. Radio transmitters will be placed on expandable collars and are expected to be retained on the moose for 1.5 to 2 years. Survival rates of calves (4-12 months old) and yearlings (13-24 months old) will be monitored for the duration of the study. Transmitters shed by animals or retrieved as mortalities will be retrieved and refurbished for future deployment to reduce program costs.

Fall GSPE surveys with correction for moose sightability will be conducted in the UKMA following the 5th year of the program, but statistically discernable population changes may not be detectable. A baseline GSPE survey was conducted in 2010 and 2011 within the UKMA and adjacent Kanuti NWR, with correction for moose sightability conducted in the 2010 survey. GSPE surveys (without sightability correction) have been conducted on the Kanuti NWR in 7 of the last 13 years. Twinning surveys will continue to be flown during the spring in Kanuti NWR as an index of nutritional condition, but twinning assessment will not be possible in the UKMA because of low density and lack of radio-collared females.

D. *Prey Harvest:*

Prey harvest will be monitored through the annual Subsistence Division household surveys and the statewide permit reporting system. Household surveys will assess moose harvest in coordination with regional and sub-regional Native entities, but will also assess total biomass utilization of other wild game species. In addition to harvest levels, hunting effort (e.g. days spent hunting, distance traveled, number of successful hunters in boat, number of hunting trips, etc.) and economic determinations will be assessed (e.g. cost of fuel, gallons of fuel used, etc.) as practical. Wolf and bear harvest will be monitored through sealing reports submitted through the annual S&I program.

If sufficient data exist, changes in harvest and catch per unit of effort (CPUE) parameters will be evaluated with respect to the treatment affects of wolf removal. It is central to this program that not only will the absolute number of harvested moose increase within the UKMA, but that subsistence hunters will experience a reduction in the hunting effort

expended to satisfy their moose harvest needs. It is fundamental to this assessment that the study design distinguishes any changes in hunting parameters caused by moose or wolf population changes, as opposed to changes in management strategies, regulations, or community circumstances affecting annual moose hunting effort. Any proposed changes in management strategy must continue to be biologically sustainable for moose and wolf populations.

IV. DECISION FRAMEWORK TO IMPLEMENT OR SUSPEND A TREATMENT

A. *Predation Control:*

1. Prey Population Abundance.

Because of the experimental nature of the UKMA program, threshold values are not applicable. Wolf control by the Department will be implemented for five years and terminated after five years regardless of detected population changes. However, population increases will represent progress toward achieving the Intensive Management Population Objective for 24(B) identified in 5 AAC 92.108.

2. Harvest Catch Per Unit Effort.

Because of the experimental nature of the UKMA program, threshold values are not applicable. Improved CPUE values are a positive outcome and do not have a negative population component that would require an early suspension of treatments.

B. *Habitat Enhancement:*

Nutritional indices such as twinning rate will not be practical to monitor in the UKMA because of low sample size (relatively few moose). A browse survey could be done, but the projected change in moose abundance is relatively low and unlikely to detect changes in proportional biomass removal.

C. *Prey Harvest Strategy:*

1. Population Abundance.

Harvest rates within Unit 24(B) were established in the Koyukuk River Moose Management Plan, and have been incorporated into the management objectives in Unit 24 (Stout 2010). The harvest rate management objective for moose in Unit 24(B) is 5% of the observable moose estimated from GSPE aerial surveys; however, actual harvest is estimated to be 3.0-3.5% of the observable moose. Hunting seasons are liberal and the bag limit allows for only bulls to be harvested. High bull:cow ratios (50-60 bulls:100 cows) have been maintained under the current management program (management objective = >30 bulls:100 cows).

Seasons and bag limits will not be restricted during the control program because recent harvest was below sustainable harvest rate objectives. Beginning in year two of the program, following two years of predation control treatments, antlerless (cow) moose

harvest will be considered if calf and yearling survival rates from radio-collared moose studies indicate substantially improved survival rates of radio-collared moose in the treatment area compared to the non-treatment area. Antlerless moose harvest may continue after 5 years of wolf control depending on public post-treatment harvest of wolves and on calf:cow (≥60 calves:100 cows), yearling bull:cow (≥20 yearling bulls:100 cows), and/or density (≥0.65 moose/mi^2) estimates from GSPE surveys conducted during regular S&I program surveys. If additional harvest is warranted, a review of current regulations that restrict access by non-local hunters may be considered.

2. Nutrition Index.

Twinning surveys will continue to be conducted on Kanuti NWR during the predation control program and at the end of the program depending on S&I program funding. If the three year average twinning rate falls below 20% (environmental effects evaluated), the moose population densities have increased, and/or habitat indicators suggest overutilization of vegetation then additional liberalized harvest of antlerless moose (cows) or calves may be considered.

V. PUBLIC INVOLVEMENT

A. *Continued Outreach by Department:*

The ability to detect changes in harvest and hunting effort with respect to the proposed treatment are the primary metrics for evaluating the success of this program, therefore, residents in the villages of Alatna and Allakaket will be vital participants in several aspects of this program. Harvest monitoring, including report of unsuccessful hunting activities, through the household surveys and permit reporting will be the most important participating activity required of community members. Department management and education staff will work with those tribal councils and regional corporations to develop a strategy for community participation. Participation and support by tribal leaders and elders will translate to broader public support of the program, and will benefit the department's ability to assess the scientific applicability of this type of program in other communities.

The Department will provide annual public newsletters to residents of Unit 24(B) regarding the management activities, regulatory actions, and public involvement. The Department will also provide information and receive input from state Fish and Game Advisory Committees, state Board of Game, federal Advisory Councils, tribal councils, and sub-regional/regional Alaska Native corporations.

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

Several parameters will be monitored to evaluate response of hunting success by local villages to the wolf control treatment of this experimental program. The combined annual harvest of up to 40 moose for the villages Alatana/Allakaket will be the primary objective, based on previous harvest levels documented in Subsistence Division household surveys in 1997-2002 (Anderson et al. 2000, Brown et al. 2004). However, hunting effort parameters such as days hunted, distance traveled, and fuel expended will also be evaluated. Qualitative

assessments of harvest such as hunter satisfaction, moose observed, and hunt conditions will also be considered.

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

We will contact the Regional Native Corporation (Tanana Chiefs Conference - TCC) to explore the possibility of them providing funding for wolf skinning. The sub-regional Alaska Native corporation (K'oyitl'ots'ina Ltd.) through the village tribal councils of Alatna and Allakaket will also be contacted to explore the possibility of them hiring and organizing local wolf skinners. Local skinners hired in the communities of Alatna and Allakaket, would mitigate income that may potentially be lost due to reduced wolf harvest opportunity by local trappers. Tribal organizations would then be responsible for organizing skinners, and managing fund disbursement. Local skinners would handle carcass disposal according to traditional cultural practices.

Local hunters and trappers will also be encouraged to continue harvest of wolves to regulate the population post-treatment to prolong the effectiveness of the predation control effort. Public harvest of wolves and bears in the established seasons will continue to be encouraged. Harvest incentive programs initiated and funded by Alaska Native corporations will also be encouraged. Incentive programs that extend to non-local wolf and bear hunters should be considered by tribal organizations (e.g. land access, supplemental funding for permitted aerial wolf hunters, etc.).

E. *Monitoring and Mitigation of Hunting Conflict:*

Harvest reporting cooperation by village hunters will be an essential component of this program. Regional and sub-regional Alaska Native entity involvement and support of the harvest monitoring will be needed to evaluate treatment effectiveness. Registration and submission of required harvest permits by all hunters will provide the Department with critical information on resource demand and harvest success. Additionally, village support of the comprehensive Subsistence Division household surveys will foster a positive working relationship with the Department, and will ensure a meaningful assessment of the relationship between moose harvest and predation control treatment.

Access to native corporation lands will be obtained for Department staff conducting moose captures, radio-transmitter recovery, and wolf control efforts. Access will be requested for Department permitted public participants in the aerial wolf control program for the purpose of wolf removal.

VI. OTHER CONSIDERATIONS None determined (see Feasibility Assessment).

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APPENDIX A. Summary of supporting information from feasibility assessment.

Geographic area and land status	
Management area(s)	Prey abundance assessment (1,360 mi^2), prey harvest assessment (13,523 mi^2), predator abundance assessment (1,360 mi^2), predator control (1,360 mi^2) – see Figure 1
Land status	125 mi^2 (9.2%) federal land (BLM/USFWS), 576 mi^2 (42.3%) Alaska Native corporation land, 659 mi^2 (48.4%) State of Alaska – see Figure 2
Biological and management situation	
Prey population	24(B) - IM objectives: 4,000-4,500 moose 24(B) - Estimate in 2010 (precision): 2,600 (±800) moose
Prey harvest (human use)	24(B) - IM objectives (rate): 150-250 moose Estimated in RY07-RY09 (SY rate): 83-109 moose (3.5% harvest rate of observable moose based on RY09 population estimate Amount Necessary for Subsistence: Unit 24 ANS=170-270 (there is no subunit ANS, RY01)
Feasibility of access for harvest	Existing travel routes: >100 river miles, <10 miles road inside village, <20 miles ATV trails, extensive snow machine access, corporation lands are closed to non-corporation members, most non-local hunters in 24(B) hunt well away from villages due to access regulations and rural residency requirements on federal lands, unleaded gasoline (average among communities): $6.50-$7.50/gal. unleaded, 100 octane low lead aviation fuel (average among communities): $8.00-8.50/gal., hunting season dates allow for boat and snow machine hunting opportunity.
Nutritional condition	Habitat is not limiting based on twinning surveys and 2007 browse assessment. Four estimates of twinning rate in previous 4 years with no significant population change (moose): 2008-36%, 2009-82%, 2010-56%, 2011-52%. In 2007, browse biomass removal for sampled plants was 5.3% (95% CL: 4.3–6.3%, n = 231 shrubs), which along with Unit 24C is the lowest measured to date in the Interior. The removal index extrapolated to the shrub counts and species composition in Unit 24(B) was 8.8% (6.8–10.8%, n = 231 shrubs. The brooming index was relatively low at 0.34 (95% CL: 0.28–0.40, *n* = 231 shrubs), and 51% of the plants had no evidence of past browsing by moose. The 2010 GSPE survey in the IM area results were; 52 bulls:100 cows, 7.6 yrlg. bulls:100 cows, 34.3 calves:100 cows.

Habitat status and enhancement potential	Proportion of IM area burned in last 10 years (potential browse availability): 0.8 mi^2 (0.06%). Proportion of area in appropriate habitat type based on vegetative classification (define as forage, cover, etc.): No field-validated vegetative classification exists for the entire subunit, however the 1992 Ducks Unlimited classification (83% overall accuracy validation) covers the SE half (52%) of the IM area and has 13% tall shrub with unknown proportion of browse vs. non-browse species. The unvalidated 2009 LANDFIRE classification of the entire IM area has 8% tall shrub.
Predator(s) abundance	Estimate in 2011 (precision): Within IM area; wolves = 50-60, black bears = 75, grizzly bears = 25
Predator(s) harvest	Reported in 2009 (SY rate): Within Unit 24(B); wolves = 20-30 (25-30%), black bears = 20-30 (6-12%), grizzly bears = 3-8 (5-6%)
Evidence of predation effects	During annual SI surveys, twinning rates $\bar{x}$ = 57%, calf:cow ratios $\bar{x}$ = 44 calves:100 cows, yearling bull ratios average 11 yearling bulls:100 cows. At predicted calving rates of 80%, spring calf ratios would yield 118 calves:100 cows, therefore, 118 calves – 44 calves = ~74 calves:100 cows are lost from approximately June 1st to November 1st (primarily bear predation). Between successive November surveys for a given cohort, of the remaining 44 calves – 22 yearlings (2x yearling bulls) = 22 yearlings:100 cows are lost per year (primarily wolf predation). Bears are likely responsible for the largest proportion of neonatal mortality (Osborne et al. 1991), whereas wolves are likely the primary predator of moose >12 months of age (Boertje et al. 2009). Based on radio-collared adults in 24A/B (2008-09), approximately 8-10% annual adult mortality.
Feasibility of predation control	Modeling of the current moose population in the proposed IM area (UKMA) using estimates of predator abundance and information, indicate the moose population will respond to wolf control to remove pre-control abundance of 45-55 wolves in the UKMA and maintaining the lower wolf abundance is forecasted to allow a gradual increase in moose abundance in the proposed IM area.
Other mortality	From 1990-2009, 45% of winters had snow > 3 feet and 85% had snow >2 feet at Bettles weather station. Blood assessment of moose radio-collared in 2007 showed low incidence of exposure to common diseases. No die-offs have been reported.

APPENDIX B. Baseline information on moose population in Unit 24(B).

I. GMU 24 – Henshaw/Peavy Creek Trend Count Area aerial moose composition counts.

Regulatory year	Survey Area (mi^2)	Bulls:100 Cows	Yrlg. Bulls: 100 Cows	Calves: 100 Cows	Twins:100 cows w/calves	Percent Calves (%)	Moose counted	Moose/mi^2
1991-1992	67	80		30		14	42	0.62
1992-1993	75.2	58	11	5		3	64	0.85
2000-2001	106	129	18	24	67	9	43	0.41
2001-2002	106	106	0	31	0	13	38	0.36
2002-2003	106	72	6	28	0	14	36	0.34
2003-2004	106	68	15	29	22	15	67	0.63
2004-2005	105.8	75.76	15.15	33.33	22.22	15.94	69	0.65

GMU 24 – Kanuti Canyon Trend Count Area aerial moose composition counts.

Regulatory year	Survey Area (mi^2)	Bulls:100 Cows	Yrlg. Bulls: 100 Cows	Calves: 100 Cows	Twins:100 cows w/calves	Percent Calves (%)	Moose counted	Moose/mi^2
1988-1989	96	118		41		16	101	1.05
1992-1993	79	77	8	27		1	106	1.34
2000-2001	86	38	7	7	0	5	87	1.01
2001-2002	86	40	9	23	0	14	57	0.66
2002-2003	86	16	4	13	0	10	72	0.84
2003-2004	86	29	11	9	0	6	62	0.72
2004-2005	85.82	40.91	0	18.18	0	11.43	35	0.41

GMU 24 – Middle Fork Trend Count Area aerial moose composition counts.

Regulatory year	Survey Area (mi^2)	Bulls:100 Cows	Yrlg. Bulls: 100 Cows	Calves: 100 Cows	Twins:100 cows w/calves	Percent Calves (%)	Moose counted	Moose/mi^2
1987-1988	78.1	49	5	21	0	13	104	1.33
2000-2001	77	13	0	43	10	27	62	0.81

2001-2002	77	36	9	18	0	12	34	0.44
2002-2003	77	0	0	33	0	25	24	0.31
2003-2004	113	23	9	24	0	16	104	0.92
2004-2005	113	37.68	5.80	21.74	0	13.64	110	0.97
2005-2006	113	33	5	14	0	11	86	0.76
2007-2008	113	41	4.92	24.6	15.4	14.9	101	0.89
2008-2009	113	40	13	18	0	11.1	99	0.87
2011-2012	113	21	4.9	29.5	5.9	19.6	92	0.81

GMU 24 – Wild River Trend Count Area aerial moose composition counts.

Regulatory year	Survey Area (mi^2)	Bulls:100 Cows	Yrlg. Bulls: 100 Cows	Calves: 100 Cows	Twins:100 cows w/calves	Percent Calves (%)	Moose counted	Moose/mi^2
2000-2001	78	22	22	44	11	27	15	0.19
2001-2002	78	33	17	33	0	20	10	0.13

GMU 24 – Upper Koyukuk River Drainage population estimation surveys.

Regulatory year	Survey area (mi^2)	Bulls: 100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins/100 cows with calves	Percent calves	Moose (90% C.I.)	Moose/mi^2
1989–1990[a] Kanuti NWR	2615	64	4.1	16.5	n/a	9.2	1171±24.7%	0.45
1993–1994[a] Kanuti NWR	2644	61	8.0	33.0	n/a	17.0	1759±18.4%	0.67
1999–2000 Kanuti NWR	2714	59	4.4	30.2	5.4	16.0	1003±20.7%	0.37
2004–2005 Kanuti NWR	2710	62	8.6	46.4	n/a	20.7	842±28.6%	0.31
2005–2006	2710	70	20.1	42.9	30.1	19.7	1026±43.3%	0.38

Kanuti NWR								
2007–2008 Kanuti NWR	2715	60	12.8	52.6	22.3	24.7	588±21.4%	0.22
2008–2009 Kanuti NWR	2715	46	14.1	57.7	9.0	28.5	872±23.2%	0.32
2010–2011 Kanuti NWR	2715	51	7.5	32.9	6.8	17.5	1068±11.5%	0.39
2011–2012 Kanuti NWR	2715	69	9.5	40.9	18.5	19.9	797±19.3%	0.29
2004-2005 Bettles block	6388	65	10.0	43.1	n/a	21.4	1596±32.9%	0.25
2004-2005 GAAR block	5106	71	7.8	23.4	n/a	13.3	1072±23.9%	0.21
2010–2011 Allakaket Area	1340	52	7.6	34.3	10.7	18.3	405±23.7%	0.30
2011–2012 Allakaket Area	1340	103	7.9	49.4	6.4	18.8	324±29.0%	0.24
1999-2000 Total block	8390	65	4.9	27.3	5.5	14.7	2662±24.4%	0.32
2004-2005 Total block	11494	65	8.6	34.8	n/a	17.8	2810±22.4%	0.24
2010–2011 Total Block	3736	53	7.5	33.3	7.2	17.7	1331±12.5%	0.35
2011–2012 Total Block	3736	78	9.8	42.9	15.7	19.5	1022±18.9%	0.27

[a] Martin and Zirkle 1996.

Unit 24A/B moose aerial twinning surveys in the Kanuti/Alatna/M. Fork Koyukuk Rivers, regulatory years 2006-07 to 2010-11.

Regulatory year	Cows w/o calves	Cows w/1 calf	Cows w/twins	Twinning %[a]	Yearlings	Dates in May
2006–2007	4	3	1	n/a	0	30,31
2007–2008[b]	n/a	32	17	35	n/a	27–31
2008–2009[b]	n/a	19	28	60	n/a	29–31
2009–2010[bc]	n/a	15	21	58	n/a	28–30
2010–2011[bd]	n/a	34	20	37	n/a	31, 6/1-2

[a] Percent of cows with calves that had twins.
[b] Radio-collared cows in sample.
[c] Early leaf-out.
[d] Including 1 cow w/3 calves.