

Moose Management Report and Plan, Game Management Units 21A and 21E:

Report Period 1 July 2015–30 June 2020, and
Plan Period 1 July 2020–30 June 2025

Jonathan S. Barton



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This species management report and plan was reviewed and approved for publication by Jason Caikoski, Management Coordinator for Region III for the Division of Wildlife Conservation.

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Purpose of this Report

This report provides a record of survey and inventory management activities for moose (*Alces alces*) in Game Management Units 21A and 21E for the 5 regulatory years 2015–2019 and plans for survey and inventory management activities in the next 5 regulatory years, 2020–2024. A regulatory year (RY) begins 1 July and ends 30 June (e.g., RY15 = 1 July 2015–30 June 2016). This report is produced primarily to provide agency staff with data and analysis to help guide and record agency efforts but is also provided to the public to inform it of wildlife management activities. In 2016 the Alaska Department of Fish and Game's (ADF&G, the department) Division of Wildlife Conservation (DWC) launched this 5-year report to report more efficiently on trends and to describe potential changes in data collection activities over the next 5 years. It replaces the moose management report of survey and inventory activities that was previously produced every 2 years and supersedes the 1976 draft Alaska wildlife management plans (ADF&G 1976).

I. RY15–RY19 Management Report

Management Area

Units 21A and 21E include the entire Innoko River drainage as well as the portion of the Yukon River between Paimiut and Blackburn Island. Additionally, Arhymot Lake, which drains into the Kuskokwim River, is also part of Unit 21E. Units 21A and 21E encompass approximately 18,792 mi².

Maps for Unit 21 can be found on ADF&G's website at <http://www.adfg.alaska.gov/index.cfm?adfg=huntingmaps.bygmu&gmu=21>.

Summary of Status, Trend, Management Activities, and History of Moose in Units 21A and 21E

Currently, moose are found throughout Units 21A and 21E. The major factors influencing moose abundance in the area include predation, weather, and hunting. Hunting pressure is primarily focused along the major river corridors.

Units 21A and 21E have distinct differences in moose habitat, user access, and hunting practices. Unit 21A contains the upper Innoko River drainage, and access is largely restricted to aircraft. There are no communities in Unit 21A, and hunters there are primarily nonlocal Alaskans and nonresidents. The communities of Grayling, Anvik, Shageluk, and Holy Cross are located in Unit 21E, and the lower Innoko and Yukon rivers are easily accessible by boat.

Direction for moose management plans has been modified over the years by the Alaska Board of Game through its regulatory actions, and by ADF&G management guidance. The Board of Game created the Paradise Controlled Use Area (CUA) in 1977 to reduce conflicts between user groups. The Paradise CUA, which lies primarily in Unit 21E between the Yukon and Innoko rivers, is closed to the use of aircraft for hunting moose, including for transporting moose hunters and their gear. This restricts access in the Paradise CUA primarily to residents with boats.

The Board of Game in March 2010 also aligned the nonresident season and resident seasons in Unit 21E: Beginning in RY10, nonresident season dates changed from 5–20 September to 5–25 September. In February 2014 the Board of Game passed proposals (Nos. 60 and 61), changing the fall moose hunt from a general harvest ticket to a registration permit and shifting the allocation of nonresident permits from 80% nonguided and 20% guided to 70% nonguided and 30% guided. Both proposals took effect in RY14.

Survey work has increased in Unit 21A with regular fall composition surveys beginning in 2007; the unit's first geospatial population estimator (GSPE) survey (Ver Hoef 2001, 2008) was conducted in March 2013. In Unit 21E, aerial composition surveys as well as GSPE surveys have been the primary means of assessing the population status. ADF&G staff collaborate closely with the U.S. Fish and Wildlife Service's Innoko National Wildlife Refuge (INWR) and the Bureau of Land Management to complete these surveys.

Unit 21E has an intensive management (IM) plan in place should moose population thresholds reach specific values (ADF&G 2017). Currently, there has been no intensive management conducted to date in Unit 21E.

Management Direction

The *Yukon–Innoko Moose Management Plan* (YIMMP; Yukon–Innoko Moose Management Working Group 2006) guides moose management in Units 21A and 21E. This plan, which was finalized in 2006, established that moose management in the area will be proactive to maintain an abundant moose population that provides for high levels of consumptive use.

EXISTING WILDLIFE MANAGEMENT PLANS

The *Yukon–Innoko Moose Management Plan* (YIMMP; Yukon–Innoko Moose Management Working Group 2006).

GOALS

The following management goals, plus the management objectives and activities that follow, are based on recommendations in *YIMMP*:

- G1. Maintain or increase moose numbers and harvest in Units 21A and 21E.
- G2. Manage predation on moose to maintain abundant moose populations.
- G3. Work to maintain optimal moose habitat.
- G4. Develop cooperative programs between state and federal agencies, and Native organizations for moose management.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

C1. Unit 21 has a customary and traditional use finding for moose with amounts reasonably necessary for subsistence (ANS) uses of 600–800 moose unitwide.

Intensive Management

C2. Unit 21E intensive management population and harvest objectives: 9,000–11,000 moose with 550–1,100 moose available for harvest annually.

C3. Unit 21E IM harvest objective is 550–1,100 moose.

C4. Unit 21E moose survey area (MSA) density objective: 1.0 moose/mi² (observable moose).

C5. Unit 21E MSA harvest objective of a minimum of 203 moose.

MANAGEMENT OBJECTIVES

Population Objectives

M1. Achieve the IM population objective of 9,000–11,000 moose in Unit 21E.

M2. Maintain a minimum posthunt ratio of 25–30 bulls:100 cows in Unit 21A and Unit 21E.

M3. Maintain a minimum posthunt ratio of 30–40 calves:100 cows in Unit 21E.

M4. Maintain at least 20% calves in the late winter moose population in Unit 21E.

Harvest Objectives

M5. Maintain a harvest of $\leq 4\%$ of the estimated moose population in Unit 21A.

M6. Maintain a harvest of $\leq 4\%$ of the estimated moose population in Unit 21E until the IM population objective has been met.

M7. Provide for a sustained harvest of up to 40 antlerless moose during a winter season in Unit 21E.

M8. Provide for the harvest of approximately 310 moose in Unit 21E by residents of Unit 21E and other Alaska residents.

MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Conduct composition-trend surveys in Unit 21A and Unit 21E annually (objectives C2, C3, C4, M1, M2, M3).

Data Needs

Composition data allow us to assess if we are meeting our management objectives for bull-to-cow and calf-to-cow ratios.

Methods

In Unit 21A during RY15–RY19, fall composition surveys were conducted annually in November by staff from the INWR. These surveys were conducted within the Innoko Trend Count Area (TCA), located along the Innoko River from the lower Dishna River mouth down to Grouch Creek, totaling 122 mi². Unit 21A was surveyed using Piper PA-18 Super Cub and CubCrafters CC18-180 Top Cub aircraft. Pilots navigated 0.25-mile transects at search intensities of 7–8 minutes/mi².

In Unit 21E during RY16–RY18, ADF&G staff flew fall composition surveys in November each year between the Innoko and Yukon rivers. Surveys were flown in PA-18 or similar aircraft at roughly 70 mph on east-west transects approximately 0.75 miles apart and 500 feet above ground level. Surveys began at a point 14 miles south of Shageluk and ended at a point 5 miles north of Holy Cross. Each moose or group of moose was circled to determine composition.

Results and Discussion

Unit 21A

The moose population in the Innoko River drainage between the lower Dishna River and Grouch Creek—the Innoko TCA—is most likely a healthy, low-density population. There was excellent calf recruitment, and an increase in the moose population during RY15–RY19 (Table 1). The bull-to-cow ratio, total moose, and total adults increased over the period. There was, however, a slight decrease in calf production during the period.

Unit 21E

We were only able to complete surveys during the 2016-2018 period. Total adults were relatively stable during this period (\bar{x} = 197; σ = 11), however calves declined during the 2018 survey to approximately 44% of the 2016-2017 average (Table 1). There were no composition surveys conducted in 2019 due to resource constraints.

The moose population in Unit 21E appeared to be stable. In 2017 the bull-to-cow ratio decreased, most likely due to very poor snow conditions affecting sightability. Snow conditions improved in 2018, reflecting a bull-to-cow ratio similar to 2016 observations. Winter in early 2018 was very hard on ungulates as late season precipitation contributed to deep snow and

overall poor body conditions in moose in Unit 21E. This most likely explains the lower calf observations in 2018.

Table 1. Units 21A and 21E fall aerial moose composition, regulatory years 2015–2019, Interior Alaska.

Survey area	Regulatory year	Bulls:100 cows	Calves: 100 cows	Total calves	Total adults	Total moose
Unit 21A	2015	43	61	64	150	214
	2016	47	53	46	126	172
	2017	49	53	67	189	256
	2018	43	33	53	229	282
	2019	54	26	44	257	301
Unit 21E	2016	40	40	55	193	248
	2017	24	38	63	209	272
	2018	42	17	23	188	211

Note: All surveys listed were done in November of that regulatory year.

Recommendations for Activity 1.1

Continue.

Activity 1.2. Assess spring twinning rates (objectives C2, M1).

Data Needs

Twinning rates are an important indicator of nutritional status and habitat quality. An assessment of body condition and productivity are integral to management on a long-term sustained yield basis and for the goal of protecting moose habitat.

Methods

ADF&G staff conducted twinning surveys in Unit 21E during late May or early June during the 2015–2019 period, from PA-18 or similar aircraft flown at approximately 70 mph and 500 feet above ground level.

In 2015, INWR staff sampled Units 21A and 21E by flying approximately 1- to 5-mile transects perpendicular to the Innoko River from Grouch Creek upstream to Rennie’s Landing. INWR staff also flew along Tolstoi Creek, starting near the Boob Creek mine, downriver to the Dishna River, and along the Dishna River to its confluence with the Innoko River.

In Unit 21E for the twinning surveys during 2016–2019, ADF&G staff broke the unit into 2 areas, Shageluk and Holy Cross. The Shageluk area consists of the area west of the community of Shageluk to the Yukon River, and the area between the Yukon and Innoko rivers to the northern portion of Unit 21E. The Holy Cross area encompasses the portion of Unit 21E east of

the community of Holy Cross on the Yukon River, to Reindeer Lake, and the Innoko River north to the community of Shageluk.

We flew east-west transects approximately 1 mile apart along the Yukon River from Paimiut to Holy Cross, and then between the Yukon and Innoko rivers from Holy Cross north to Anvik and Shageluk. All moose observed were recorded; however, only cows with calves were classified as adult cows with single or twin/triplet calves. The twinning rate was calculated as the number of cows with twins/triplets divided by the number of cows with calves.

Results and Discussion

For Unit 21E during 2016–2019, ADF&G staff conducted surveys in the 2 areas—the Shageluk survey area and the Holy Cross survey area; Tables 2a and 2b show the results from those surveys.

Table 2a. Shageluk area twinning rates, Unit 21E, calendar year 2016–2019, Interior Alaska.

Calendar year	Total moose	Total calves	Percent calves	Cows with calves	Singletons	Twins	Twinning rate (percent)
2016	109	28	26	23	16	7	30
2017	212	74	35	50	26	24	48
2018	267	71	27	54	38	16 ^a	30
2019	170	78	46	58	38	20	34
2020 ^b	—	—	—	—	—	—	—
2-year average							32

^a Includes 1 set of triplets.

^b Survey was not completed in calendar year 2020.

Table 2b. Holy Cross area twinning rates, Unit 21E, calendar years 2016–2019, Interior Alaska.

Calendar year	Total moose	Total calves	Percent calves	Cows with calves	Singletons	Twins	Twinning rate (percent)
2016	199	60	30	44	28	16	36
2017	425	132	31	104	78	30	27
2018	417	72	17	66	60	6	9
2019	317	91	29	80	69	11	14
2020	126	49	39	40	31	9	23
2-year average							19

Twinning rates within the Shageluk area display a healthy population with adequate habitat available for potential growth. Lower densities and large riparian wetlands provide good habitat for browse and remain common habitat choice for adult cows with neonates to escape predators.

The lower portions of Unit 21E within the Holy Cross survey area generally have higher densities of moose, which most likely explains the disparity between twinning rates from the adjacent northern Shageluk area. Hard snow years in 2017 and 2018 may have also impacted the twinning rates in the Holy Cross area.

Recommendations for Activity 1.2

Continue.

ACTIVITY 1.3. Assess population size through GSPE surveys (objectives C1–C3, M1, M4–M8).

Data Needs

Estimates of population size help us to determine the harvestable surplus in relation to IM objectives and ANS.

Methods

To estimate moose population size and density in Unit 21E, we conducted aerial surveys in late February or early March using the GSPE method (Ver Hoef 2001, 2008; Kellie and DeLong 2006). We did not conduct GSPE surveys in Unit 21A.

We conducted 2 GPSE surveys in Unit 21E—in 2016 and 2019. All survey units were stratified as high or low density at the start of each survey. A simple random sample of survey units was selected from each stratum, and additional survey units were selected to fill gaps in the randomized coverage. A sightability correction factor (SCF) was obtained during these surveys. Radiocollared moose were used to estimate sightability using the ratio of unseen to seen collars ($SCF = 1/[\text{not seen}/\text{seen}]$).

Results and Discussion

Unit 21A

There were no GSPE surveys conducted in Unit 21A during RY15–RY19; the most recent GSPE survey in the unit was in 2013, where we estimated 1,047 moose (90% CI = 796–1,298) in the survey area with a density of 0.30 moose/mi² (Table 3). This was the first GSPE survey conducted in Unit 21A.

Unit 21E

The two GPSE moose estimates (2016, 2019) indicated a relatively stable moose population and an increase from the last estimate in 2012. The average total moose density increased approximately 58% from the previous reporting period during RY10–RY14 (Table 3).

Before 2016, the most recent survey had been in 2012. That year we estimated 5,398 moose (90% CI = 4,372–6,424), which included correction with a SCF (Table 3).

Recommendations for Activity 1.3

Continue.

2. Mortality-Harvest Monitoring and Regulations

ACTIVITY 2.1. Monitor harvest through registration permits, general season harvest reports, and drawing permits; analyze harvest data; and assess the accuracy of these data in selected areas when possible (objectives M5, M6, M7, M8).

Data Needs

Unit 21E has been identified by the Board of Game for IM of moose. There are also subsistence regulations in place that set the ANS throughout Unit 21. Annual summaries of harvest are necessary to understand harvest in relation to IM, subsistence, and sustained yield. Analysis of harvest data also informs department recommendations to the Board of Game.

Methods

Reporting data on registration permits, general season hunts, and drawing permits are collected from hunters. These data are then tallied and assessed using ADF&G's Wildlife Information Network (WinfoNet). Hunters can report online, in person at department offices, or by mailing hard copies of their hunt report to Wildlife Conservation Information Services.

Season and Bag Limit

Regulations for Units 21A and 21E can be found on ADF&G's website at <http://www.adfg.alaska.gov/index.cfm?adfg=wildliferegulations.hunting>.

Results and Discussion

Accurate harvest reporting is essential to managing moose in Units 21A and 21E. We will continue to work with the local Fish and Game advisory committees and license vendors to stress the importance of harvest reporting. We will also continue to work from the department's McGrath office to follow up with individuals to ensure accurate and timely harvest reporting as required by regulation.

Harvest by Hunters

Summaries of reported harvest in Units 21A and 21E are presented in Tables 4a and 4b. In Unit 21A, harvest and participation remain stable and consistent, with success rates averaging 57%.

Table 3. Summary of spring geospatial moose population estimates in Units 21A and 21E, survey years 2012–2019, Interior Alaska.

Location and survey year	Survey area (mi ²)	Strata size (mi ²)		Area searched (mi ²)		Total search area (mi ²)	No. of moose estimated by strata and density (moose/mi ²)				Total estimate [90% CI ^a]	Average density moose/ mi ²	No. of sample units counted
		low	high	low	high		low		high				
Unit 21A ^b 2013 GSPE ^c	3,821	3,244	577	315	577	892	681	(0.2)	366	(0.6)	1,047 [796-1,298]	0.3	150
Unit 21E ^d 2012 GSPE	4,044	3,145	899	229	696	925	1,470	(0.5)	3,928	(4.4)	5,398 [4,372-6,424]	1.3	150
Unit 21E ^d 2016 GSPE	4,094	2,779	1,314	320	579	899	2,419	(0.9)	5,953	(4.5)	8,372 [6,865-9,879]	2.0	146
Unit 21E ^d 2019 GSPE	4,094	2,115	1,979	296	629	925	717	(0.3)	7,890	(4.0)	8,607 [6,283-10,931]	2.1	150

^a CI stands for confidence interval.^b This survey does not include an applied sightability correction factor (SCF).^c GSPE stands for geospatial population estimate.^d Unit 21E surveys include applied SCF values.

Table 4a. Unit 21A reported moose harvest, regulatory years 2015–2019, Interior Alaska.

Regulatory year	Bulls	Cows	Unknown	Total	Total hunters	Harvest success (percent)
2015	63	0	0	63	103	61
2016	55	0	0	55	98	56
2017	78	0	0	78	132	59
2018	60	0	0	60	119	50
2019	74	0	0	74	129	57

Table 4b. Unit 21E reported moose harvest, regulatory years 2015–2019, Interior Alaska.

Regulatory year	Bulls	Cows	Unknown	Total	Total hunters	Harvest success (percent)
2015	167	0	0	167	278	60
2016	203	2	0	205	303	68
2017	209	0	1	210	320	66
2018	212	0	0	212	333	64
2019	179	0	0	179	272	66

Unit 21E harvest increased dramatically in RY14, and RY15–RY19 harvest levels are consistent with this increase. This data more accurately reflects the actual level of moose harvest, as prior to RY14, nonreporting was a significant issue. The registration permit RM836 was initiated in RY14 and has greatly increased accurate harvest reporting. Interest in Unit 21E from both resident and nonresident moose hunters remains high, and harvest/participation will most likely steadily increase over the next years in conjunction with healthy moose populations in this area.

Harvest information for specific hunt types, harvest success, harvest chronology, and transportation are available to the public for hunt planning on the ADF&G website at <https://secure.wildlife.alaska.gov/index.cfm?adfg=harvest.main>.

Other Mortality

Under regulation Title 5 Alaska Administrative Code (AAC) 92.019, hunters are permitted to take moose for customary and traditional Alaska Native funerary or mortuary religious ceremonies. In Unit 21E, 11 moose were taken under this regulation during RY15, 6 were taken each year during RY16–RY18, and 5 were taken during RY19. No moose were taken under the regulation in Unit 21A during RY15–RY19.

Predation is likely an important factor affecting moose population dynamics in Units 21A and 21E, based on calf mortality studies in adjacent areas on the lower Nowitna, Koyukuk, and Kuskokwim drainages (Osborne et al. 1991; Gasaway et al. 1992; Boertje et al. 2009). Keech et al. (2011) found that the primary cause of moose calf mortality in Unit 19D was predation by black bears, grizzly bears, and wolves. Deep snow has also been shown to affect moose survival (Coady 1974).

There are 2 federal subsistence permits—FM2104 and FM2105—available for qualified users from 15 February through 15 March in Unit 21E. FM2104 is available for qualified rural residents of Unit 21E, Aniak, Chuathbaluk, Kalskag, Lower Kalskag, and Russian Mission. FM2104 is valid on federal lands in Unit 21E south of a line intersecting the mouth of Paimiut Slough. FM2105 is available for qualified rural residents of Unit 21E and Russian Mission; it is valid on federal lands north of a line intersecting the mouth of Paimiut Slough.

Unit 21E federal harvest reporting for both FM2104 and FM2105 indicates 3 moose were harvested (2 cows and 1 bull) in 2015, 9 moose were harvested (4 bulls and 5 cows) in 2016, 12 moose were harvested (6 bulls and 6 cows) in 2017, 10 moose were harvested (5 bulls, 5 cows) in 2018, and 4 bull moose were harvested in 2019.

Alaska Board of Game Actions and Emergency Orders

RY16

The Board of Game at its March 2010 meeting adopted an IM plan (5 AAC 92.124) authorizing wolf control in Unit 21E if the moose population falls below 1.0 observable moose/mi². During its February 2017 meeting, the board reauthorized this plan for RY17–RY22. The ADF&G commissioner may authorize the removal of wolves, black bears, and brown bears until the plan expires on 30 June 2023. The moose population is currently above this threshold, and no wolf control is planned at this time.

In February 2017, the Board of Game also adopted a proposal to change the start date of the Alaska resident moose season in Unit 21E from 5 September to 1 September, extending the resident hunting season by 5 days (1–25 September).

RY19

During the Board of Game’s February 2020 meeting, the following regulations were established:

The board adopted a proposal that changed the general season moose hunt in Unit 21A to a registration hunt (RM835) to help facilitate better reporting and gain more accurate data on moose harvest.

The board established a resident registration hunt (RM837) from 15 February through 15 March in Unit 21E. Under RM837, any moose are available for harvest except cows accompanied by calves. Season quotas are established by the department, and aircraft restrictions within the Paradise CUA still apply.

The board amended 5 AAC 92.011(k)(3) to allow proxy hunting in Units 21A and 21E under a one-antlered bull bag limit.

The board adopted a proposal to require nonresident hunters to complete hunter orientation prior to hunting moose in Units 21A and 21E.

The board passed a regulation to require meat to be left on the bone on moose harvested in Units 21A and 21E. The front quarters, hind quarters, and ribs are required to be left on the bone when salvaged prior to 1 October.

No emergency orders were issued during RY15–RY19.

Recommendations for Activity 2.1

Continue.

3. Habitat Assessment-Enhancement

No activities for moose habitat assessment or enhancement are included in Units 21A and 21E moose management.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

There were no nonregulatory management needs during RY15–RY19.

Data Recording and Archiving

GSPE data are stored in the GSPE moose survey application in WinfoNet. Other moose survey data are located on files in the department's McGrath office.

Agreements

Currently there are no agreements with other agencies pertaining to moose management.

Permitting

No permits were needed to conduct moose management activities in Units 21A and 21E during RY15–RY19.

Conclusions and Management Recommendations

Moose populations in Units 21A and 21E appear to be stable to increasing. Looking specifically at Unit 21A, the current population estimate is 2,442 observable moose. This value is based on older GSPE data from 2013 (average density of 0.3 moose/mi²; Table 3). Because this estimate is not corrected for sightability, it is a conservative estimate. Despite this data being older, stable harvest and composition suggest a healthy population in the unit. Because of limited resources, Unit 21A GSPE surveys are difficult to accomplish. An additional decrease in priority occurs because there are no communities in Unit 21A directly dependent on moose populations.

The 2019 population estimate for all Unit 21E is 9,777 moose. GSPE data from 2012–2019 indicates a growing population trend in the unit and meets our management objective for IM population density (C4).

For both Units 21A and 21E, the objective to maintain a minimum posthunt ratio of 25–30 bulls:100 cows (M2) was met. For Unit 21E, the objective to maintain a minimum posthunt ratio of 30–40 calves:100 cows was met in RY16 and RY17. The ratio was significantly lower in RY17 most likely due to heavy snow loads the previous winter, and surveys were not conducted in RY19 due to resource constraints.

Unit 21A has a negative finding for IM, and there are no management actions we can take to improve calf-to-cow ratios. For Unit 21E, the objective to maintain at least 20% calves in the late winter moose population (M4) was not met in 2019. Data collected from the GSPE survey conducted in February of that year resulted in 11% calves. This value most likely represents the effects from the previous winter that had icing events and deep snow. Calving data is gathered during late winter GSPE surveys, and new data will be collected February 2022.

We averaged the twinning rates from the Shageluk and Holy Cross survey areas in Unit 21E. Twinning rates on a 2-year average remain at or above 20% for the combined survey areas. This indicates a stable population with a positive trajectory for growth. Because the 2-year average twinning rate is at 12% in the Holy Cross survey area, we will start stabilization with a winter registration permit hunt passed by the Board of Game in RY19.

The objective to maintain harvest of $\leq 4\%$ of the estimated population in both Units 21A and 21E (M5 and M6) was met during RY15–RY19. We also met the objective of providing for a sustained harvest of up to 40 antlerless moose during a winter season in Unit 21E (M7). The current estimate of harvestable surplus is 390 moose. The average annual harvest of 195 is below that level, and with the new registration permit in place, we are better able to assess harvest.

The RM836 moose registration permit in Unit 21E has provided increased accurate harvest reporting since RY14. This registration permit has been a successful tool to monitor harvest and participation more accurately in conjunction with harvestable surplus and management objectives.

During the March 2020 Board of Game meeting, a proposal was passed to establish an any moose winter registration moose hunt for residents only in Unit 21E. Increasing population densities and lowering twinning rates suggest that adequate additional harvest is available, and an any moose hunt will help inhibit growth outside the population carrying capacity (Boertje et al. 2007). This new hunt will help toward meeting our management objective of providing up to 40 antlerless moose in Unit 21E (M7) in the future.

Monitoring moose numbers in Unit 21E continues to be a priority. If the population falls below 1 moose/mi² (observable), the department has been authorized to conduct wolf control. To monitor this threshold, we will need continued funding for GSPE surveys and maintaining radio collars on moose to obtain estimates of sightability.

Generally, we have sufficient resources to conduct 1 population estimate (or a portion of 1) per year; 3 fall composition surveys, dependent on weather; and 1–3 spring twinning surveys.

Therefore, we recommend conducting a single moose population estimate each year, and rotating these surveys on a 3-year cycle, recognizing that we will occasionally be unable to conduct surveys due to weather. Unit 21A is not part of this cycle, but we will continue to monitor moose here, opportunistically, and in close cooperation with the USFWS's INWR office. The INWR office has provided significant support and contributions to moose management and population monitoring in Units 21A and 21E, and interagency cooperation remains highly successful.

II. Project Review and RY20–RY24 Plan

Review of Management Direction

MANAGEMENT DIRECTION

There are no suggested changes in the management direction.

GOALS

YIMMP was finalized in 2006 and guides moose management in Units 21A and 21E. This plan established that moose management in the area would be proactive to maintain an abundant moose population that provides for high levels of consumptive use. The following management goals, management objectives, and activities are based on recommendations in *YIMMP*:

- G1. Maintain or increase moose numbers and harvest in Units 21A and 21E.
- G2. Manage predation on moose to maintain abundant moose populations.
- G3. Work to maintain optimal moose habitat.
- G4. Develop cooperative programs between state and federal agencies, and Native organizations for moose management.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

- C1. Unit 21 has a customary and traditional use finding for moose with amounts reasonably necessary for subsistence (ANS) uses of 600–800 moose unitwide.

Intensive Management

- C2. Unit 21E IM population objective is 9,000–11,000 moose.
- C3. Unit 21E IM harvest objective is 550–1,100 moose.
- C4. Unit 21E MSA density objective: 1.0 moose/mi² (observable moose).
- C5. Unit 21E MSA harvest objective of a minimum of 203 moose.

MANAGEMENT OBJECTIVES

Population Objectives

- M1. Achieve the IM population objective of 9,000–11,000 moose in Unit 21E.
- M2. Maintain a minimum posthunt ratio of 25–30 bulls:100 cows in Unit 21A and Unit 21E.
- M3. Maintain a minimum posthunt ratio of 30–40 calves:100 cows in Unit 21E.
- M4. Maintain at least 20% calves in the late winter moose population in Unit 21E.

Harvest Objectives

- M5. Maintain a harvest of $\leq 4\%$ of the estimated moose population in Unit 21A.
- M6. Maintain a harvest of $\leq 4\%$ of the estimated moose population in Unit 21E until the IM population objective has been met.
- M7. Provide for a sustained harvest of up to 40 antlerless moose in a winter season in Unit 21E.
- M8. Provide for the harvest of approximately 310 moose in Unit 21E by residents of Unit 21E and other Alaska residents.

REVIEW OF MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Conduct composition-trend surveys in Unit 21A and Unit 21E annually (objectives C2, C3, C4, M1, M2, M3).

Data Needs

No change from RY15–RY19. Composition data will allow us to assess if we are meeting our management objectives for bull-to-cow and calf-to-cow ratios.

Methods

We will evaluate bull-to-cow ratio estimates (90% CI) in relation to the lower limit of the bull-to-cow ratio management objective for Units 21A and 21E.

Before the next survey, consistent methods will be considered, and survey areas will be designed and planned to optimize sample size and repeatability. In addition, biometricians will be consulted prior to the surveys to determine the best method to compare survey ratios with the management objective, as well as the best method to achieve the desired optimum precision, and sample sizes needed.

We will continue to utilize the support provided by the USFWS INWR for Unit 21A composition surveys. The consistency and reliability of the INWR surveys has been a valuable addition to the data resources we apply to monitor moose populations.

ACTIVITY 1.2. Assess spring twinning rates (objectives C2, M1).

Data Needs

No change from RY15–RY19. Twinning surveys need to be conducted to collect twinning rate data, which serve as indicators for body condition and productivity for cows. An assessment of body condition and productivity are integral to management on a sustained yield basis for the long term and for the goal of protecting moose habitat.

Methods

- No change from RY15–RY19.
- Evaluate 2-year average twinning rates in Unit 21E in relation to the objectives outlined in the IM operational plan for Unit 21E.
- If the 2-year average twinning rate is (a) $\geq 20\%$, we will continue to promote population growth; (b) is 15–20%, we will attempt to stabilize moose numbers through harvest; and (c) $< 15\%$, we will attempt to reduce the number of moose through harvest. Predator control will not be initiated or will be suspended if harvest alone is insufficient to reduce moose numbers.

ACTIVITY 1.3. Assess population size through GSPE surveys and compare to objectives (objectives C1–C3, M1, M4–M8).

Data Needs

We intend to estimate annual abundance, productivity, and survival-recruitment-escapement to evaluate population status and trend. Periodically scheduled estimates of abundance with associated precision will be used to monitor population size and calf-to-cow ratios to evaluate whether IM population and harvest objectives are being met, if harvestable surplus is adequate for ANS objectives, and estimate harvestable surplus to provide for maximum hunter opportunity through seasons and bag limits.

Methods

We will continue to assess moose densities in Unit 21E with GSPE surveys (Kellie and DeLong 2006) conducted in late winter. We recognize the challenges of observing moose in late winter surveys (e.g., shadows in dense cover on sunny days) and intend to estimate an SCF with each GSPE using radiomarked moose or other appropriate techniques.

Due to resource constraints, we will attempt to conduct a GSPE survey in Unit 21E every 3 years. However, funding, weather, and other area priorities may prevent this. All GSPE surveys will be designed to achieve precision of at least $\pm 20\%$ at the 90% confidence interval, but actual precision will vary with survey conditions and funding. The next survey is slated to be completed in winter 2022.

Desired precision will be evaluated through biometric review prior to surveys. Consultation with biometricians will be sought to ensure that trends can be evaluated, given the low frequency of surveys. Biometric review will also be sought prior to future GSPE surveys to optimize the allocation of high-to-low strata sampled, establish sightability trials, as well as to refine the comparison of survey results with the IM objectives.

2. Mortality-Harvest Monitoring

ACTIVITY 2.1. Monitor harvest through registration permits, general season harvest reports, and drawing permits; analyze harvest data; and assess the accuracy of these data in selected areas when possible (objectives M5, M6, M7, M8).

Data Needs

No change from RY15–RY19. Unit 21E has been identified by the Board of Game for IM of moose. Subsistence regulations in place set ANS throughout Unit 21. Annual summaries of harvest are necessary to understand harvest in relation to IM, subsistence, and sustained yield. Additionally, analysis of harvest data informs department recommendations to the Board of Game.

Methods

Harvest will be assessed using data from harvest reports stored in the harvest database in WinfoNet.

For intensive management purposes, we will monitor total harvest for comparisons with the IM harvest objective (methods will be those described in “I. RY15–RY19 Management Report | 2. Mortality-Harvest Monitoring and Regulations | Methods” of this document).

We will compare reported harvest to the lower limit of the IM harvest objective using 3-year running means to account for annual variation in harvest.

3. Habitat Assessment-Enhancement

No activities for moose habitat assessment or enhancement are expected in Units 21A and 21E moose management.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

In January 2005, the Yukon–Innoko Moose Management Working Group convened to develop a plan to proactively manage moose populations in the area. *YIMMP* was the result of this process (Yukon–Innoko Moose Management Working Group 2006). This plan is now 15 years old and may need to be reevaluated in the next 5 to 10 years.

Maintaining or improving moose habitat was recommended by the working group, and habitat quality was assessed in Unit 21E in 2006. However, no habitat assessment work has been conducted in Unit 21A (Paragi et al. 2008). Continued habitat assessments may be conducted; however, twinning surveys, an index of population nutrition, will be our primary metric of habitat quality.

Low-snow winters have made conducting a GSPE in Unit 21E more difficult in recent years. We canceled the winter 2015 survey due to low snow. There was enough snow for us to conduct the survey in 2016. However, snow was marginal at the beginning of the 2016 survey, and by the time of completion, the snow had mostly melted from the southern portion of the survey area. New survey techniques may need to be developed to alleviate this issue. In 2019 we conducted the GSPE at the end of February to try and account for the low-snow conditions in the fall. Snow conditions noticeably deteriorated by late February during the survey, suggesting future efforts for GSPE surveys in this area may need to be conducted earlier in February.

Snow conditions for composition surveys are a noticeable challenge in the fall. Alternate methods may need to be explored for the future if late snow fall inhibits accurate counts.

Data Recording and Archiving

GSPE data are stored in WinfoNet using the moose survey application. Other moose survey data are located in files in the department's McGrath office. Historic data will be archived in the WinfoNet data archiving system as time permits.

Agreements

The *Yukon–Innoko Moose Management Plan* (*YIMMP*; Yukon–Innoko Moose Management Working Group 2006).

Permitting

No permits are expected in the RY20-RY24 period.

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