Moose
Management Report
of survey-inventory activities
1 July 1999–30 June 2001

Carole Healy, Editor
Alaska Department of Fish and Game
Division of Wildlife Conservation
December 2002

ADF&G

Please note that population and harvest data in this report are estimates and may be refined at a later date.

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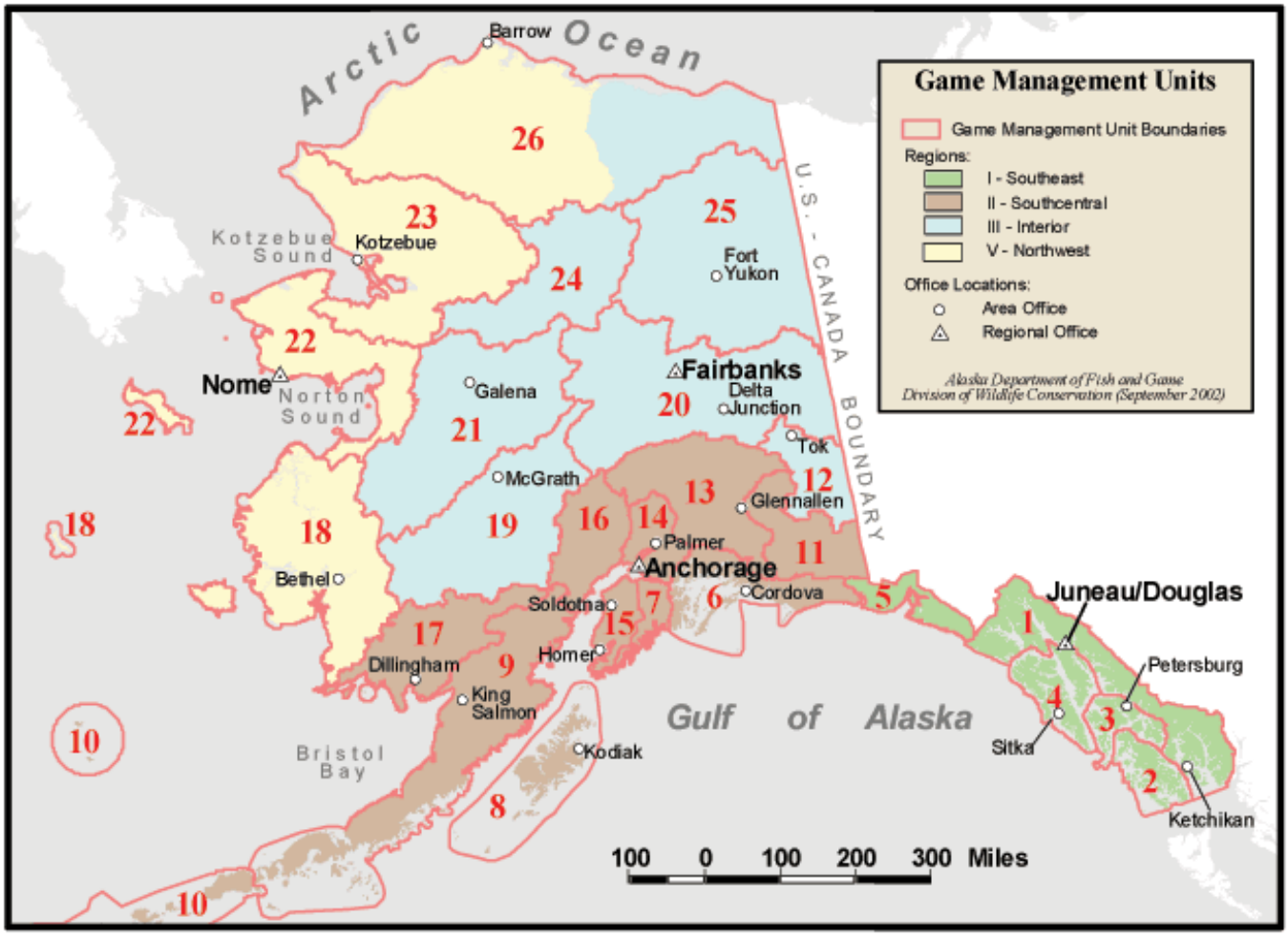
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U.S. - CANADA BOUNDARY
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Game Management Units
Game Management Unit Boundaries
Regions:
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MOOSE MANAGEMENT REPORT

From: 1 July 1999
To: 30 June 2001

LOCATION

GAME MANAGEMENT UNIT: 20A (6796 mi^2)

GEOGRAPHIC DESCRIPTION: Tanana Flats, Central Alaska Range

BACKGROUND

Moose are found throughout the foothills of the Alaska Range and the Tanana Flats at exceptionally high densities relative to similarly sized areas throughout North America. Unit 20A moose are a world class wildlife resource. Gasaway et al. (1983) presented a detailed history of the Unit 20A moose population through 1978, while Boertje et al. (1996) presented a history through 1995.

Preferred moose habitat is composed of riparian willow, poorly drained meadows, shallow lakes, early successional forest, and subalpine shrub communities. Approximately 5040 mi^2 of the unit comprises moose habitat.

Moose numbers increased in Unit 20A during the 1950s and reached high densities in the early 1960s, perhaps 4–5 moose/mi^2. Annual moose harvests averaged 311 moose between 1963 and 1969 (McNay 1993). During 1969–1974, harvest increased to an average of 617 moose per year. Cow moose comprised 34% of the annual harvest during 1963–1974.

Similar to numerous other ungulate populations in Alaska, the moose population declined beginning in the late 1960s and reached its lowest point in the mid-1970s. Beginning in 1975, seasons and harvests were dramatically reduced and taking of cows was prohibited. In late winter 1976 the division implemented a program to reduce wolf numbers. During 1975–1978, mean annual moose harvest was limited to 64 bulls.

During wolf reduction efforts in Unit 20A (1976–1982), the moose population increased rapidly and has increased or remained stable most years since 1982. During 1979–1982, harvests averaged 226 bulls per year (McNay 1993). During 1983–1993 the mean annual harvest increased to 358 bulls. A wolf control program to reduce predation on the declining Delta caribou herd began in October 1993, but was discontinued in December 1994. Division staff reduced wolf numbers by trapping and snaring and may have influenced moose population dynamics.

Regulations provide a variety of hunting opportunities in Unit 20A, but a large majority of the harvest occurs during the general September bulls-only season. The southwestern portion of the unit currently includes the Wood River Controlled Use Area (WRCUA; no motorized access except aircraft), the Ferry Trail Management Area (FTMA; harvest limited to bulls with spike-fork or 50-inch antlers), the Healy Lignite Management Area (HLMA; bowhunting only), the Yanert Controlled Use Area (YCUA; no motorized access except aircraft, with harvest limited to bulls with spike-fork or 50-inch antlers), and the Nenana Controlled Use Area (NCUA; restricts the use of airboats for hunting moose).

Approximately one-third of Unit 20A is military land, including 1003 mi^2 of Fort Wainwright Army property, 893 mi^2 of Fort Greely Army property, and 17 mi^2 of Clear Air Force Station property. A variety of access restrictions, both spatial and temporal, apply to portions of these military lands.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.

MANAGEMENT OBJECTIVES

- Manage for a November population of between 10,000 and 12,000 moose.
- Manage for a posthunting sex ratio of ≥30 bulls:100 cows overall and ≥20 bulls:100 cows in the Tanana Flats, Western Foothills, and Eastern Foothills areas.

METHODS

POPULATION STATUS AND TREND

1999 Population Estimation Survey

We surveyed 86 survey units (SU) (52 high moose density, 34 low moose density; 500 mi^2) of 987 SUs (5747 mi^2) during the period 6–17 November. We were unable to survey 2 planned SUs due to restricted air space over military lands or turbulence. Eight of the 86 SUs were additional units added in the FTMA to increase sampling effort in that area. In all, we surveyed 18 of 98 SUs in the FTMA. We used the Geostatistical Population Estimator method (GSPE; Ver Hoef 2001), a modification of the standard Gasaway et al. (1986) technique. We dry-lab stratified Unit 20A into low and high moose density strata based on an earlier 4 strata classification of the area. Medium-, high-, and super-high density strata from the 4 strata classifications were combined into a single "high-density" stratum. Where a SU contained both high- and low-density strata, the stratum found in greatest abundance was assigned to the unit (e.g., if a SU contained 51%

high-density and 49% low-density strata, the stratum assignment was "high-density"). Sixty percent of the SUs surveyed were high density, and 40% surveyed were low density. A simple random sample of SUs was selected from each stratum using Microsoft®Excel Windows®98 software. "Tanana Flats" and "Foothills" portions of Unit 20A, which were treated as separate geographic strata in 1996, 1997, and 1998 surveys, were combined in the 1999, 2000, and 2001 analyses.

The GSPE method does not employ a sightability correction factor (SCF), thus does not correct for moose not seen during the survey. Rather, the GSPE method employs greater search intensity, 8–10 min/mi^2 vs. 4–6 min/mi^2 (Gasaway et al. 1986), resulting in a higher level of sightability.

Search intensity averaged 4.5 min/mi^2, considerably less than the recommended 8–10 min/mi^2. However, search intensity was not corrected for areas of non-moose habitat (e.g., >4500 feet in elevation or large bodies of water) that were not searched. Therefore, actual search intensity was certainly greater, although probably still below recommended levels. Interior Alaska received over 12" of snow in late October and early November. Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were reported mostly as excellent (34%) and good (61%) with the remainder reported as fair (5%). Turbulence was not a factor during surveys, although surveys were suspended several days due to high or turbulent winds.

2000 Stratification Surveys

We stratified 468 SUs (approximately 2575 mi^2) of 987 SUs (5747 mi^2) on 17 October and 8–10 November. Unit 20A was subdivided into SUs with north–south boundaries every 2 degrees of latitude and east–west boundaries every 5 degrees of longitude. This resulted in nearly square SUs that were approximately 5.7 mi^2. They included all areas of suitable moose habitat ≤4500 feet elevation. Sample units entirely above 4500 feet elevation were excluded from the survey because land higher in elevation is not considered suitable moose habitat (Gasaway et al. 1986). However, if any portion of an SU was ≤4500 feet, the entire SU was included in the survey. Surveys were flown in a Cessna 206 traveling at approximately 90 nautical mi/h and, generally, 400–500 feet AGL. Surveys were conducted with 2 observers (aft port and starboard) and 1 recorder (fore starboard). Criteria used to define strata within SUs included number of moose observed, number of tracks observed, and overall habitat quality (low, medium, high with respect to relative amount of browse cover observed). Sample units were classified as low- or high-density stratum.

2000 Population Estimation Survey

We surveyed 114 SUs (69 high density, 45 low density; 627 mi^2) of 987 SUs (5747 mi^2) during the period 30 October–9 December using GSPE methods described above. Fourteen of the 114 SUs were additional units added in the FTMA, YCUA, and WRCUA to increase sampling effort in those areas. In all, we surveyed 13 of 82 SUs in the FTMA, 12 of 65 in the YCUA, and 26 of 160 in the WRCUA.

Search intensity averaged 6.7 min/mi^2, less than the recommended 8–10 min/mi^2. However, search intensity was not corrected for areas of non-moose habitat (e.g., >4500 feet in elevation or

large bodies of water) that were not searched. Therefore, actual search intensity was certainly greater and probably reached recommended levels. The area received adequate snowfall for surveys by the third week of October and additional snow fell periodically throughout the remainder of the survey period. Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were reported mostly as good (44%) with the remainder reported as excellent (26%) or fair (29%). Turbulence was not a factor during surveys, although surveys were suspended several days due to high or turbulent winds.

2001 Stratification Surveys

We stratified 430 SUs (approximately 2365 mi^2) of 987 SUs (5747 mi^2) on 11–13 November using the methods described above.

2001 Population Estimation Surveys

We surveyed 78 (50 high-density and 28 low-density; 455 mi^2) of 987 SUs (5747 mi^2) during 31 October–18 November using the methods described above.

Search intensity averaged 6.9 min/mi^2, slightly less than the recommended 8–10 min/mi^2. However, search intensity was not corrected for areas of non-moose habitat (e.g., >4500 feet in elevation or large bodies of water) that were not searched. Therefore, actual search intensity was certainly greater and probably reached recommended levels. Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were reported primarily as good (70%) with the remainder reported as excellent (18%) or poor (12%). Snow conditions tended to deteriorate as the survey period progressed. Turbulence was not a factor, although surveys were suspended several days due to high or turbulent winds.

Twinning Surveys

Twinning rates in 2000 and 2001 were estimated from a radiocollared sample of moose in the central portion of Unit 20A. Approximately 30 fixed-wing radiotracking flights were flown each year between mid-May and mid-June to measure twinning rates. Twinning rate was calculated as the proportion of cows with twins or triplets from the sample of all cows greater than 2 years old accompanied by calves.

HARVEST

We estimated annual harvest from harvest report cards. This included data from report cards from the general season and drawing hunts for antlerless moose in the central Tanana Flats and bulls in the eastern portion of the WRCUA. Reminder letters were sent to nonreporting general season hunters, and up to 2 letters were sent to permit holders who failed to report. Harvest parameters summarized included hunter residency, hunter success, harvest chronology, and transport methods. When antler size of bulls was reported, we considered bulls with antler spreads <30 inches to be yearlings. Harvest data were summarized by regulatory year (RY), which begins 1 July and ends 30 June (e.g., RY00 = 1 Jul 2000–30 Jun 2001).

We estimated other mortality from Department of Public Safety records of collisions with motor vehicles and Alaska Railroad records of collisions with trains.

WEATHER

We evaluated weather (snowfall and temperature) using National Weather Service records and personal observations.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

We estimated 11,205 (9636–12,774; 90% CI) moose in 1999, 10,557 (8657–12,457; 90% CI) in 2000, and 11,511 (9784–13,238; 90% CI) in 2001 (Table 1). Population estimates in 1996–2001, excluding the 1997 estimate, which had relatively poor precision (±27%, 90% CI), indicate that the Unit 20A moose population has likely stabilized at approximately 10,500–11,500 animals or about 2.1–2.3 moose/mi^2.

Population Composition

In 1999 we classified 965 moose and estimated 33 calves:100 cows and 23 bulls:100 cows (Table 1). In 2000 we classified 1337 moose and estimated 33 calves:100 cows and 23 bulls:100 cows. In 2001 we classified 887 moose and estimated 26 calves:100 cows and 26 bulls:100 cows. The relatively low calf:cow ratio in 2001 was likely the result of low parturition rates that year (R Boertje, ADF&G, unpublished data). Bull:cow ratios declined from 39 bulls:100 cows in 1996 to 23 bulls:100 cows in 1999 (Table 1). Bull:cow ratios were significantly ($Z = 2.51$, 1 df, $P < 0.05$) lower in 1999 than 1998, and the decline resulted in bull:cow ratios falling below the Unit 20A management objective of 30 bulls:100 cows. Bull:cow ratios have remained below the management objective since 1999.

We met our objective of ≥20 bulls:cows in the Tanana Flats, Western Foothills, and Eastern Foothills portions of Unit 20A. In 2000 the estimated number of bulls:100 cows was 22, 23, and 28 in the Tanana Flats, Western Foothills, and Eastern Foothills, respectively. In 2001 bull:100 cow ratios were similar in the Tanana Flats (26:100) and Western Foothills (22:100), but higher in the Eastern Foothills (40:100).

In the southwestern portion of Unit 20A, where numerous trails provide motorized access, the bag limit has been 1 bull with spike-fork or 50-inch antlers (subsequently referred to as SF50) since RY88. This antler restriction was adopted in response to declining bull:cow ratios between RY84 (23–42 bulls:100 cows; Jennings 1986) and RY87 (13–27 bulls:100 cows; McNay 1989). Bull:cow ratios improved during the early 1990s, presumably because of the antler restriction. For example, bull:cow ratios exceeded the management objective for the Western Foothills of 20 bulls:100 cows in 1993 (31 bulls:100 cows in the Walker Dome trend area). However, since the mid 1990s, bull:cow ratios in the FTMA declined from an estimated 26:100 in 1994 to 9:100 in 2001. In addition, in the Western Tanana Flats, bull:cow ratios have been at or below 20

bulls:100 cows in both 2000 (20:100) and 2001 (17:100). Unitwide antler restrictions that will go into effect in RY02 may improve bull:cow ratios in these areas.

Twinning Rates

Twinning rates remain poor and have been extremely low 3 of the past 4 years (Table 2). This is consistent with other measures of poor productivity, such as low parturition rates, reproductive pauses, and delayed age of first reproduction, indicating that the Unit 20A moose population is nutritionally stressed (Boertje et al. 1999) because of high moose densities and, presumably, declining habitat quality.

Distribution and Movements

The moose population is distributed throughout Unit 20A, consisting of nonmigratory and migratory subpopulations (Gasaway et al. 1983). From February to April some bull and cow moose migrate from the surrounding foothills (Alaska Range and Chena and Salcha River drainages) to calving areas on the Tanana Flats in Unit 20A. They remain there for the summer and return to the foothills from August through October. Although we do not know what proportion of the moose migrate, Gasaway et al. (1983) estimated that the seasonal migrants probably increase the density of moose on the Tanana Flats 2- to 4-fold over the density of resident Unit 20A moose.

MORTALITY

Harvest

Seasons and Bag Limits. Seasons and bag limits in Unit 20A during RY99 were as follows:

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 20A, the Ferry Trail Management Area and the Yanert Controlled Use Area.		
RESIDENT HUNTERS: 1 bull with spike-fork antlers or 50-inch antlers or antlers with 3 or more brow tines on 1 side.	1 Sep–25 Sep (General hunt only)	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 3 or more brow tines on 1 side.		1 Sep–25 Sep
Unit 20A within the Nenana Controlled Use Area		

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
RESIDENT HUNTERS: 1 bull.	1 Sep–25 Sep (General hunt only)	
NONRESIDENT HUNTERS: 1 bull.		1 Sep–25 Sep
Remainder of Unit 20A.		
1 moose per regulatory year only as follows:		
RESIDENT HUNTERS: 1 bull; or	1 Sep–25 Sep (General hunt only)	
1 antlerless moose by drawing permit only; up to 300 permits may be issued; or	1 Sep–25 Sep (General hunt only)	
1 bull by drawing permit only; by muzzleloading firearms only; up to 75 permits may be issued.	1 Nov–30 Nov (General hunt only)	
NONRESIDENT HUNTERS: 1 bull; or		1 Sep–25 Sep
1 antlerless moose by drawing permit only; up to 300 permits may be issued; or		1 Sep–25 Sep
1 bull by drawing permit only; by muzzleloading firearms only; up to 75 permits may be issued.		1 Nov–30 Nov

Seasons and bag limits in Unit 20A during RY00 were as follows:

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 20A, the Ferry Trail Management Area and the Yanert Controlled Use Area.		
RESIDENT HUNTERS: 1 bull with spike-fork antlers or 50-inch antlers or antlers with 4 or more brow tines on 1	1 Sep–20 Sep (General hunt only)	

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
side. NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side.		1 Sep–20 Sep
Unit 20A within the Nenana Controlled Use Area. RESIDENT HUNTERS: 1 bull.	1 Sep–20 Sep (General hunt only)	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side.		1 Sep–20 Sep
Remainder of Unit 20A. 1 moose per regulatory year only as follows: RESIDENT HUNTERS: 1 bull; or	1 Sep–20 Sep (General hunt only)	
1 antlerless moose by drawing permit only; up to 300 permits may be issued; or	1 Sep–25 Sep (General hunt only)	
1 bull by drawing permit only; by muzzleloading firearms only; up to 75 permits may be issued.	1 Nov–30 Nov (General hunt only)	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side; or		1 Sep–20 Sep
1 antlerless moose by drawing permit only; up to 300 permits may be issued; or		1 Sep–25 Sep
1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side by drawing permit only; by muzzleloading firearms only; up to 75 permits may be issued.		1 Nov–30 Nov

Alaska Board of Game Actions and Emergency Orders. In RY91 the bag limit for the FTMA and YCUA was 1 bull moose with spike-fork or 50-inch antlers or antlers with 3 or more brow tines on 1 side (SF50/3). During RY92–RY95 the bag limit for the FTMA and YCUA was 1 bull moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side (SF50/4). During RY96–RY99 the bag limit was changed back to 1 bull moose with SF50/3. Then in RY00 the Board of Game again increased the brow tine requirement to SF50/4 in these areas. At that time, the board also restricted the bag limit for nonresident hunters in all of Unit 20A to 1 bull moose with 50-inch antlers or antlers with 4 or more brow tines on 1 side. Those bag limits remained in effect through the RY01 hunting season.

The board reauthorized 3 antlerless moose hunts by drawing permit in RY99 and RY00. Two (DM760 and DM762) occurred on the northcentral Tanana Flats near Fairbanks where moose densities were high. DM760 ran from 1–13 September while DM762 ran from 14–25 September. The third antlerless hunt (DM764) occurred during 1–25 September in the eastern portion of the WRCUA.

The board made no changes during this reporting period to muzzleloader permit hunt DM766 created in RY96. This bulls-only hunt allows the department to issue up to 75 permits for hunters using muzzleloaders in a portion of the WRCUA during November. Seventy-five permits were issued in RY99, but no permits were issued during the RY00 or RY01 hunting seasons.

The board created the Nenana Controlled Use Area (NCUA) in portions of Units 20A and 20C in RY96, which prohibited the use of airboats for hunting or transporting moose hunters or their gear during 1–25 September. The NCUA was modified in RY98 to allow the use of airboats for hunting moose within the main channels of the Teklanika, Toklat, and Nenana Rivers, and at the public boat launch in Nenana.

The board modified the common boundary between the FTMA and WRCUA from the Totatlanika River to Tatlanika Creek in RY98. The boundary was changed back to the Totatlanika River in RY00. Although there was action at the spring 2002 Board of Game meeting to move the boundary back again to Tatlanika Creek, the proposal failed.

Intensive Management (IM) deliberations for Unit 20 were postponed during the spring 2000 meeting until November, at which time the board adopted IM population (10,000–12,000 moose) and harvest (500–720 moose) objectives for Unit 20A.

Alaska Board of Game Actions, March 2002 — The Alaska Board of Game took action to restrict resident bag limits for moose throughout Unit 20A beginning RY02. The resident bag limit for the FTMA, HLMA, WRCUA, and YCUA will be 1 bull moose with SF50/4. The resident bag limit in the remainder of Unit 20A will be 1 bull moose with SF50/3. The nonresident bag limit was unaffected and will remain 1 bull moose with 50-inch antlers or antlers with 4 or more brow tines on 1 side.

The board reauthorized up to 300 antlerless drawing permits (hunts DM760, DM762 and DM764) for 1–25 September in Unit 20A. The board also authorized an antlerless hunt by registration permit, 1–25 September, for the Unit 20A portion of the NCUA (i.e., the Western Tanana Flats). In addition, the board authorized up to 300 drawing permits for calf moose for the

period 1–25 September. This hunt is experimental and will be revisited by the board in 2004. Finally, the board authorized that recipients of antlerless drawing registration permits and calf drawing permits be prohibited that year from hunting for antlered bull moose in Unit 20A.

Hunter Harvest. Reported harvest of bull moose in Unit 20A increased 66% between RY90–RY91 ($\bar{x}$ = 376 bulls) and RY96–1997 ($\bar{x}$ = 625 bulls), and then remained relatively stable through RY99 (Table 3). Liberalizing the general season from 20 to 25 days in RY95 likely contributed to the increased harvest. The harvest of bull moose declined to less than 550 in RY00 and RY01 after the season was reduced by 5 days (1–20 Sep) and antler restrictions were adopted unitwide for nonresident hunters.

Permit Hunts. Hunter participation and harvest was lower than expected for antlerless drawing permit hunts through RY01 (Table 4). This may partly be explained by many permittees choosing to take bull moose rather than filling their antlerless permit. To increase participation and harvest in future permit hunts, the board adopted a regulation prohibiting recipients of drawing and registration permits for antlerless and calf moose from taking an antlered bull moose in Unit 20A.

Hunter Success and Residency. Hunter success rates during the general hunting season tended to be higher in Unit 20A (Table 5) than surrounding subunits (i.e., 20B, 20C, 20F and 25C; Selinger 2000; Young 2000*a,b*). Success rates reached their highest level in 10 years in RY99 (42%). In RY00 and RY01, success rates were lower than those reported for the previous 5 regulatory years (RY95–RY99). This was likely a function of reduced season length; success rates were higher in years with a 25-day season (RY95–RY99) than years with a 20-day season (RY90–RY94 and RY00–RY01). Nonresidents had higher success rates than residents.

The number of hunters reporting hunting moose in Unit 20A increased during the early to mid-1990s, but has remained relatively constant since RY96. A 40% increase between RY94 (n = 1166) and RY96 (n = 1636) was likely due, at least in part, to the liberalization of the general moose season in RY95 from 20 to 25 days. However, a reduction in season length from 25 to 20 days beginning in RY00 did not result in a commensurate reduction in the number of moose hunters.

Harvest Chronology. Moose harvest in Unit 20A has traditionally been well distributed throughout the season (Table 6). In RY99 the most productive harvest periods were 11–15 and 16–20 September. However, during RY00–RY01, slightly more bull moose were reported taken early (1–5 Sep) and late (16–20 Sep) in the season than during the middle (6–15 Sep) of the season.

Transport Methods. During the last 10 regulatory years, approximately two-thirds of the successful moose hunters used airplanes or boats (including airboats; Table 7). Hunting by horseback was popular in the YCUA and the southern portion of the WRCUA. Three- and 4-wheeler use increased during the early-to-mid 1990s, but appears to have stabilized. The FTMA continued to be a popular place for hunters using 3- and 4-wheelers. In addition, hunters increasingly used boats to transport these vehicles to the Tanana Flats.

Airboat use remains controversial. Since RY97, airboats have been distinguished as a transportation category on harvest report cards. The percentage of successful moose hunters in Unit 20A that used airboats has been relatively stable during RY97–RY01 (Table 6).

Other Mortality

A study of moose mortality began in 1996, and a progress report is available (Boertje et al. 1999).

The number of moose killed in accidents with motor vehicles and trains has been substantial in some years, but was relatively low during RY99–RY00 (Table 3). This may be the result of average snowfall during winters 1999–2000 (70.0 in) and below average snowfall in 2000–2001 (56.6 in).

WEATHER

Unusual weather may have influenced moose population dynamics during RY90–RY01. Winter 1990–1991 had the highest snowfall on record in Fairbanks (147.3 in) and was closely followed by 1992–1993 (139.1 in). These record snowfalls are over twice the long-term average (68 in). In contrast, winters 1997–1998 (46.0 in), 1998–1999 (31.0 in), and 2001–2002 (25.5 inches through Jan 2002) received less than normal accumulations of snow.

Summer 1992 was probably the shortest on record. It was bracketed with snowfall in mid-May and in September (24 inches of snowfall, 3 times the previous record, and cold temperatures, 13 degrees colder than previous record). Conversely, 1993 was likely the longest summer on record, with an early spring leaf-out, warm summer temperatures, and a late fall.

HABITAT

There has been considerable discussion in recent years about the potential for Unit 20A to support many more moose. We remain concerned about the population exceeding the habitat capability and becoming vulnerable to severe weather patterns. Already, we have documented that this population has the lowest productivity of studied moose populations in North America (Boertje et al. 2000). Therefore, a higher moose density is not desirable until habitat improves. Two large wildfires (114,000 acre Survey Line Burn and 85,000 acre Fish Creek Burn) occurred on the Tanana Flats during summer 2001, but potential benefits to the moose population will likely not be realized for many years. Mortality research implemented in 1996 is evaluating many factors influencing the status of the moose population relative to habitat, predators, and sustainable harvest.

NONREGULATORY PROBLEMS/ISSUES

An electric intertie that will bisect important moose habitat in western Unit 20A is currently under construction between Healy and Fairbanks. Construction on the selected Rex–South route will probably affect moose in 2 ways. First, the intertie corridor may improve access, and changes in regulations to prevent local overharvest of bulls may be necessary. More importantly, increased fire suppression near the corridor may adversely affect habitat capability for moose

over time. We forwarded these concerns to appropriate land use agencies, and the line has been routed so that minimal effects on fire suppression will occur.

CONCLUSIONS AND RECOMMENDATIONS

Population estimates from 1996–2001 indicate the Unit 20A moose population has stabilized within the range of our population objective. However, estimates also suggest that the number of adult (≥1 year of age) cows in the population has been slowly increasing, while the number of bulls has been slowly declining. Low twinning rates, 0% yearling pregnancy rates, delayed age of first reproduction, and reproductive pauses are all indicative of a relatively unproductive moose population. Current research indicates that moose production in Unit 20A is reduced because of high moose densities and, presumably, declining habitat quality. Therefore, I recommend we continue to conduct antlerless moose hunts (i.e., DM760, DM762, and DM764) in the high moose density areas of the northcentral Tanana Flats and eastern WRCUA. Antlerless moose harvest should be evaluated as a tool to prevent an overabundance of moose that are vulnerable to the synergistic effects of adverse weather and increased predation. In addition, it is important to improve habitat quality and determine the status of the Unit 20A moose population relative to nutrient–climate limitations, and increasing predator numbers (Boertje et al. 1996).

Although we met our management objective of 20 bulls:100 cows in the Tanana Flats, Western Foothills and Eastern Foothills, we did not meet our management objective of 30 bulls:100 cows unitwide. Consequently, I recommend reducing the reported harvest of bull moose to ≤400 (≤300 adult bulls and the remainder yearlings) until bull:cow ratios recover. Low bull:cow ratios have been a chronic problem in the FTMA and YCUA, hence antler restrictions since the late 1980s. In RY01, ratios in the Western Tanana Flats dropped below 20 bulls:100 cows for the first time. Regulations adopted by the Board of Game in 2002, which were aimed at reducing the harvest of bull moose in Unit 20A (i.e., unitwide antler restrictions, antlerless and calf hunts, restrictions preventing hunters holding cow or calf permits from taking antlered bull moose in 20A), should result in improved bull:cow ratios in these areas, as well as, Unit 20A overall. I recommend we continue to closely monitor bull:cow ratios both at unitwide and lesser spatial scales (e.g., management area, controlled use area, and sub-areas) to monitor the effects of current regulatory changes on bull:cow ratios.

We met the Board of Game's IM population and harvest objectives of 10,000–12,000 moose and 500–720 moose, respectively, during this reporting period. However, with unitwide antler restrictions going into effect in RY02 and the bull harvest expected to drop to about 400 animals or less, I recommend a limited number of calves and additional cows be taken to maintain the harvest level within IM guidelines.

LITERATURE CITED

BOERTJE RD, P VALKENBURG, AND M MCNAY. 1996. Increases in moose, caribou, and wolves following wolf control in Alaska. *Journal of Wildlife Management* 60:474–489.

———, MA KEECH, AND BW DALE. 1999. Factors limiting moose at high densities in Unit 20A. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Progress Report. Grant W-27-1. Study 1.51. Juneau, Alaska.

———, CT SEATON, DD YOUNG, MA KEECH, AND BW DALE. 2000. Factors limiting moose at high densities in Unit 20A. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grant W-27-3. Study 1.51. Juneau, Alaska.

GASAWAY WC, SD DUBOIS, DJ REED, AND SJ HARBO. 1986. Estimating moose population parameters from aerial surveys. Biological Paper 22, University of Alaska Fairbanks.

———, RO STEPHENSON, JL DAVIS, PEK SHEPHERD, AND OE BURRIS. 1983. Interrelationships of wolves, prey, and man in Interior Alaska. *Wildlife Monographs* 84.

———, RD BOERTJE, DV GRANDGAARD, DG KELLYHOUSE, RO STEPHENSON, AND DG LARSEN. 1992. The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. *Wildlife Monographs* 120.

JENNINGS LB. 1986. Unit 20A moose management progress report of survey–inventory activities. Pages 72–76 *in* B Townsend, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grant W-22-4. Job 1.0. Juneau, Alaska.

MCNAY ME. 1989. Unit 20A moose management progress report of survey–inventory activities. Pages 212–224 *in* S Morgan, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grant W-23-1. Study 1.0. Juneau, Alaska.

———. 1993. Units 20B and 25C moose management progress report of survey–inventory activities. Pages 244–266 *in* SM Abbott, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grants W-23-3 and W-23-4. Study 1.0. Juneau, Alaska.

SELINGER JS. 2000. Units 20C, 20F, and 25C moose management progress report of survey–inventory activities. Pages 337–350 *in* MV Hicks, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grants W-27-1 and W-27-2. Study 1.0. Juneau, Alaska.

YOUNG DD. 2000*a*. Unit 20A moose management progress report of survey–inventory activities. Pages 300–318 *in* MV Hicks, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grants W-27-1 and W-27-2. Study 1.0. Juneau, Alaska.

———. 2000*b*. Unit 20B moose management progress report of survey–inventory activities. Pages 319–336 *in* MV Hicks, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grants W-27-1 and W-27-2. Study 1.0. Juneau, Alaska.

VER HOEF JM. 2001. Predicting finite populations from spatially correlated data. 2000 Proceedings of the Section on Statistics and the Environment of the American Statistical Association, pp 93–98.

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Table 1 Unit 20A fall (Oct–Dec) aerial moose composition counts and estimated population size, 1990–2001

Calendar year	Bulls:100 Cows	Yearlings: 100 Cows	Calves:100 Cows	Percent calves	Adults	Moose observed	Moose/mi^2	Estimated population size (90% CI)
1990[a]	23, 24, 26	15	48	27	584	292, 180, 158	2.0	10,100
1991[b]	22, 32	15	34	21	1954	949, 1531	2.2	11,100
1992[a]	28, 31, 36	14	36	21	274	107, 105, 137	2.2	11,300
1993[b]	29, 30	19	38	23	1340	852, 883	2.4	11,900
1994[c]	35	23	46	25	1038	1391	2.6	13,300
1995[d]	--	--	--	28	--	575	--	--
1996	39	24	42	23	2578	3343	2.3[e]	11,500 (± 13%)
1997	33	28	34	21	816	1037	2.6[e]	12,935 (± 27%)
1998	31	18	31	18	1035	1268	2.2[e]	11,144 (± 19 %)
1999	23	13	33	21	760	965	2.2[f]	11,205 (± 14%)
2000	23	10	33	21	1089	1377	2.1[f]	10,557 (± 18 %)
2001	26	18	26	17	737	887	2.3[f]	11,511 (± 15%)

[a] Windy, Walker Dome, and Japan Hills trend areas, respectively.
[b] Central Tanana Flats and Western Foothills, respectively.
[c] Central Tanana Flats and Western Foothills combined.
[d] Lack of snow prevented early winter surveys.
[e] Corrected for sightability (SCF = 1.15).
[f] Geo-statistical Population Estimation method does not incorporate a SCF (see methods).

Table 2 Unit 20A Tanana Flats moose twinning rates, 1987–2001

Calendar year	Date	Cows w/Single calf	Cows w/Twins	Cows Total	% Twins[a]
1987		45	5	50	10
1988		52	8	60	13
1989	20–24 May[b]	43	8	51	16
1990	24 May	25	7	32	22
1991	20–21 May	19	5	24	21
1992[c]					
1993	28 May	28	0	28	0
1994	22 May	42	9	51	18
1995	22 May	43	3	46	7
1996	26 May	33	7	40	18
1997	21 May	26	3	29	10
1998	26–30 May	51	4	55	7
1999	25–26 May	62	2	64	3
2000[d]	14 May–9 June	26	3	29	10
2001[d]	14 May–6 June	27	1	28	4

[a] Percentage of cows with calves that had twins.

[b] Includes data from surveys when paired helicopter/fixed-wing observations were made (20–21 May) and when only fixed-wing observations were made (24 May).

[c] No calving surveys done.

[d] Based on data from radiocollared moose ≥5 years of age, which results in higher estimates than traditional twinning rate surveys in which 3- and 4-year-old moose that are less likely to produce twin calves are included.

Table 3 Estimate of Unit 20A moose harvest[a] and accidental death, regulatory years 1990–1991 through 2001–2002

Regulatory year	Harvest by hunters							Accidental death			Total
	Reported				Estimated						
	M	F	Unk	Total	Unreported[b]	Illegal/Other[c]	Total	Road[d]	Train[e]	Total	
1990–1991	370	0	0	370	65		65				435
1991–1992	382	0	0	382	68		68				450
1992–1993	246	0	0	246	44		44				290
1993–1994	386	0	0	386	68		68				454
1994–1995	399	0	0	399	71		71				470
1995–1996	526	0	0	526	93		93				619
1996–1997	617	61	0	678	120		120				798
1997–1998	629	68	2	699	124	11	135	2	17[e]	19	853
1998–1999	613	74	4	691	122	3	125	3	15[e]	18	834
1999–2000	663	1	16	680	120	5	125	3	11[e]	14	819
2000–2001	541	74	5	620	110	9	119	2	34[e]	36	775
2001–2002	537	72	6	615	109	4[f]	113	0[f]	2[g,h]	2	730[i]

[a] Includes general and permit hunt harvest.
[b] Based on 17.7% unreported harvest (including wounding loss) estimated by Gasaway et al. (1992).
[c] Includes illegal, DLP, dispatched, potlatch, stickdance, and other reported deaths.
[d] Documented kills; actual number killed by vehicles is certainly greater.
[e] Confirmed dead between Alaska Railroad (ARR) mileposts 327.0 and 411.7 (ARR mileposts 327.0 through 369.9 are located in Unit 20C near the Unit 20A border); "Missing" (moose hit but not recovered) are not included. Data provided by the Alaska Railroad.
[f] Number of moose killed through December 2001.
[g] Confirmed dead between ARR mileposts 371.0 and 411.7; "Missing" (moose hit but not recovered) are not included. Data provided by the Alaska Railroad.
[h] Number of moose killed through April 2002.
[i] Preliminary.

Table 4 Unit 20A moose harvest data by permit hunt, regulatory years 1996–1997 through 2001–2002

Hunt	Regulatory year	Permits issued	Did not hunt	(%)	Unsuccessful hunters	(%)	Successful hunters	(%)	Bulls	(%)	Cows	(%)	Unk	(%)	Harvest
760	1996–1997	75	19	(25)	31	(55)	25	(45)	0	(0)	25	(100)	0	(0)	25
	1997–1998	75	17	(23)	32	(55)	26	(45)	0	(0)	26	(100)	0	(0)	26
	1998–1999	75	13	(17)	32	(52)	30	(48)	0	(0)	30	(100)	0	(0)	30
	1999–2000	0	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
	2000–2001	75	14	(19)	32	(52)	29	(48)	1	(3)	28	(97)	0	(0)	29
	2001–2002	75	22	(29)	25	(47)	28	(53)	0	(0)	28	(100)	0	(0)	28
762	1996–1997	75	24	(32)	24	(47)	27	(53)	1	(4)	26	(96)	0	(0)	27
	1997–1998	75	23	(31)	24	(46)	28	(54)	4	(14)	24	(86)	0	(0)	28
	1998–1999	75	22	(29)	23	(43)	30	(57)	3	(10)	27	(90)	0	(0)	30
	1999–2000	0	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
	2000–2001	75	18	(24)	27	(47)	30	(53)	2	(7)	28	(93)	0	(0)	30
	2001–2002	75	22	(29)	26	(49)	27	(51)	3	(11)	24	(89)	0	(0)	27
764	1996–1997	150	107	(71)	34	(79)	9	(21)	2	(22)	7	(78)	0	(0)	9
	1997–1998	150	107	(71)	34	(79)	9	(21)	1	(11)	8	(89)	0	(0)	9
	1998–1999	150	87	(58)	54	(86)	9	(14)	0	(0)	9	(100)	0	(0)	9
	1999–2000	0	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
	2000–2001	150	100	(67)	37	(74)	13	(26)	1	(8)	12	(92)	0	(0)	13
	2001–2002	150	97	(65)	33	(42)	20	(58)	2	(10)	18	(90)	0	(0)	20
766	1996–1997	75	43	(57)	22	(69)	10	(31)	10	(100)	0	(0)	0	(0)	10
	1997–1998	75	43	(57)	18	(56)	14	(44)	14	(100)	0	(0)	0	(0)	14
	1998–1999	75	39	(52)	25	(69)	11	(31)	11	(100)	0	(0)	0	(0)	11
	1999–2000	75	32	(43)	23	(54)	20	(46)	20	(100)	0	(0)	0	(0)	20
	2000–2001	0	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
	2001–2002	0	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
Totals	1996–1997	375	193	(51)	111	(61)	71	(39)	13	(18)	58	(82)	0	(0)	71

Hunt	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Bulls (%)	Cows (%)	Unk (%)	Harvest
for all permit hunts	1997–1998	375	190 (51)	108 (58)	77 (42)	19 (25)	58 (75)	0 (0)	77
	1998–1999	375	161 (43)	134 (63)	80 (37)	14 (18)	66 (83)	0 (0)	80
	1999–2000	75	32 (43)	23 (53)	20 (47)	20 (100)	0 (0)	0 (0)	20
	2000–2001	300	132 (44)	96 (57)	72 (43)	4 (6)	68 (94)	0 (0)	72
	2001–2002	300	138 (46)	84 (53)	75 (47)	5 (7)	70 (93)	0 (0)	75

Table 5 Unit 20A moose hunter[a] residency and success, regulatory years 1990–1991 through 2001–2002

Regulatory year	Successful						Unsuccessful						Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	(%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	(%)	
1990–1991	257	43	61	9	370	(31)	651	122	52	15	840	(69)	1210
1991–1992	264	62	48	8	382	(33)	566	148	48	10	772	(67)	1154
1992–1993	150	51	32	13	246	(25)	549	113	59	15	736	(75)	982
1993–1994	281	54	39	12	386	(34)	571	108	32	24	735	(66)	1121
1994–1995	270	67	45	17	399	(34)	605	103	43	16	767	(66)	1166
1995–1996	390	68	64	4	526	(37)	709	107	37	8	861	(62)	1387
1996–1997	427	102	73	5	607	(37)	830	134	61	4	1029	(63)	1636
1997–1998	406	110	98	5	619	(39)	738	163	65	10	976	(61)	1595
1998–1999	367	131	108	2	608	(37)	816	158	64	6	1044	(63)	1652
1999–2000	378	144	132	6	660	(42)	674	166	67	7	914	(58)	1574
2000–2001	338	133	73	4	548	(34)	723	204	115	2	1044	(66)	1592
2001–2002	348	132	57	2	539	(35)	691	215	78	5	989	(65)	1528

[a] Excludes hunters in permit hunts.
[b] Residents of Unit 20.

Table 6 Unit 20A moose harvest[a] chronology percent by month/day, regulatory years 1990–1991 through 2001–2002

Regulatory year	Harvest chronology percent by month/day					Unk/Other	*n*
	9/1–9/5	9/6–9/10	9/11–9/15	9/16–9/20	9/21–9/25		
1990–1991	27	12	27	29	1	3	370
1991–1992	24	19	28	25	0	3	382
1992–1993	45	24	13	16	0	2	246
1993–1994	34	19	25	17	1	4	386
1994–1995	27	20	23	25	0	5	382
1995–1996	19	17	21	22	15	4	526
1996–1997	26	15	19	22	14	4	607
1997–1998	24	15	17	22	18	4	619
1998–1999	22	15	17	24	19	3	608
1999–2000	20	15	25	22	15	2	660
2000–2001	26	18	25	27	0	3	548
2001–2002	24	21	23	29	0	3	539

[a] Excludes permit hunt harvest.

Table 7 Unit 20A moose harvest[a] percent by transport method, regulatory years 1990–1991 through 2001–2002

Regulatory year	Harvest percent by transport method									*n*
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Airboat	Unknown	
1990–1991	37	6	31	9	0	9	4		3	370
1991–1992	34	5	29	14	0	10	5		3	382
1992–1993	33	4	27	16	2	10	7		2	246
1993–1994	34	2	37	12	0	6	7		2	386
1994–1995	29	3	33	22	0	8	5		0	399
1995–1996	30	4	35	17	0	7	4		2	526
1996–1997	28	3	32	20	0	10	4		3	607
1997–1998	32	4	22	23	0	5	6	5	3	619
1998–1999	37	3	19	22	0	7	4	7	1	608
1999–2000	37	5	18	20	0	11	4	5	1	660
2000–2001	37	5	19	19	0	10	3	5	2	548
2001–2002	34	5	19	20	0	10	3	7	1	539

[a] Excludes permit hunt harvest.

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MOOSE MANAGEMENT REPORT

From: 1 July 1999
To: 30 June 2001

LOCATION

GAME MANAGEMENT UNIT: 20B (9114 mi^2)

GEOGRAPHIC DESCRIPTION: Drainages into the north bank of the Tanana River between Delta Creek and Manley Hot Springs

BACKGROUND

Moose numbers increased in Unit 20B throughout the 1950s and early 1960s after extensive wildfires improved moose habitat and federal predator reduction programs reduced wolf predation on moose (McNay 1993). Moose numbers declined following severe winters in 1965, 1970, 1971, and 1974. Increasing wolf predation and liberal either-sex hunting seasons contributed to the moose population decline. By 1976 moose densities were low and the hunting season had been reduced to 10 days in most of Unit 20B. Moose populations again increased following wolf reduction programs conducted from 1980 to 1986. Hunting seasons were extended from 10 days in 1981 to 20 days from 1983 to 1987. Reported harvests increased to approximately 300 bulls per year from 1983 to 1986. Harvests increased further from nearly 400 bulls in 1987 and 1988 to over 700 bulls in 1998, despite a 5-day reduction in the season.

Demand for moose hunting opportunities is high and increasing in Unit 20B. Extensive road systems and trails provide overland access, and numerous waterways such as the Tolovana, Tatalina, Chatanika, Goldstream, Salcha, and Chena Rivers provide boat access.

There were 2 permit moose hunts in Unit 20B during this reporting period, 1 in the Minto Flats Management Area (MFMA) and 1 in the Fairbanks Management Area (FMA). The MFMA was established in 1979 to restrict harvest in a low-density moose population. In 1988 the Alaska Legislature established the Minto Flats State Game Refuge to ensure the protection and enhancement of habitat; the conservation of fish and wildlife; and to guarantee the continuation of hunting, fishing, trapping, and other compatible public uses within approximately 900 mi^2 of the Minto Flats area.

The FMA was established in 1983 to provide moose hunting opportunities around the Fairbanks urban area by bow and arrow only. The area was closed to hunting in the late 1970s and early 1980s. Boundaries of the FMA changed numerous times, with the most recent changes going into effect in July 2002. The FMA currently encompasses about 300 mi^2, of which about 50 mi^2

has a relatively dense human population. Even though harvest is generally low, this hunt is popular.

For management purposes, Unit 20B is divided into 3 geographic zones: Unit 20B West (2942 mi^2), including the Minto Flats, Tatalina Creek drainage, Tolovana River drainage, and areas west; Unit 20B East (2425 mi^2) including the Little Salcha and Salcha River drainages; and Unit 20B Central (3829 mi^2), the remainder. Game management unit boundaries changed in 1981, increasing the size of Unit 20B and creating Unit 25C. Prior to 1981, the eastern and western portions of present-day Unit 20B and all of Unit 25C were considered part of Unit 20C. In 1993 the Unit 20B Central boundary was shifted westward. During regulatory year (RY) 2000, which begins 1 July and ends 30 June (e.g., RY00 = 1 Jul 2000–30 Jun 2001), Unit 20B West and Unit 20B Central boundaries were modified to coincide with Uniform Coding Unit (UCU) boundaries. As a result, the area of Unit 20B West decreased by approximately 1000 mi^2 and Unit 20B Central increased by that same amount.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide for continued subsistence use of moose by Alaska residents who have customarily and traditionally used the population.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.
- Protect human life and property in human–moose interactions.

MANAGEMENT OBJECTIVE

- Manage for a posthunting sex ratio of ≥30 bulls:100 cows unitwide and ≥20 bulls:100 cows in each count area (i.e., Unit 20B East, Unit 20B Central, Unit 20B West, and MFMA).

METHODS

POPULATION STATUS AND TREND

1999 Stratification Surveys

We stratified 649 sample units (SU) (3644 mi^2) in Unit 20B West on 9–11 November 1999. Unit 20B was subdivided into SUs with north–south boundaries every 2 degrees of latitude and east–west boundaries every 5 degrees of longitude. This resulted in nearly square SUs that were approximately 5.5 mi^2. They included all areas of suitable moose habitat ≤4500 feet elevation. Sample units entirely above 4500 feet elevation were excluded from the survey because land above that elevation is not considered suitable moose habitat (Gasaway et al. 1986). However, if

any portion of an SU was ≤4500 feet, the entire SU was included in the survey. Surveys were flown in a Cessna 206 traveling at approximately 90 nautical mi/h, generally, 400–500 feet above ground level (AGL). Surveys were conducted with 2 observers (aft port and starboard) and 1 recorder (fore starboard). Criteria used to define strata within SUs included number of moose observed, number of tracks observed, and overall habitat quality (low, medium, or high with respect to the relative abundance of browse observed). Sample units were stratified as either low or high moose density.

1999 Population Estimation Survey

We surveyed 54 (26 low and 28 high moose density; 304 mi^2) of 649 SUs (3644 mi^2) in Unit 20B West, including 42 (20 low and 22 high density; 236 mi^2) of 169 SUs (951 mi^2) in the MFMA on 14–23 November 1999. We used the Geostatistical Population Estimator method (GSPE; Ver Hoef 2001), a modification of the standard Gasaway et al. (1986) technique. A simple random sample of SUs was selected from each stratum using Microsoft®Excel for Windows®98 software. Previous analyses suggest survey effort and the precision of population estimates are optimized when the survey effort includes approximately 40% low density and 60% high-density sample units. However, during this survey, sampling effort of low- and high-density strata was comparable due to statistical constraints requiring a minimum sample size of approximately 25 SUs per stratum.

The GSPE method does not employ a sightability correction factor (SCF), so does not correct for moose not seen during the survey. Rather, the GSPE method employs greater search intensity of 8–10 min/mi^2 vs. 4–6 min/mi^2 (Gasaway et al. 1986), resulting in a higher level of sightability.

Search intensity averaged 4.8 min/mi^2, considerably less than the recommended 8–10 min/mi^2. Interior Alaska received adequate snowfall (>12") for surveys by early November. Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were mostly excellent (32%) and good (39%) with the remainder fair (22%) or poor (7%). Turbulence was not a factor during surveys, although surveys were suspended several days due to high or turbulent winds.

2000 Stratification Surveys

We stratified 979 SUs (5385 mi^2) in Units 20B East and 20B Central on 13 and 16 October and 21, 24, and 28 November using the methods described above. This completed stratification of Unit 20B.

2000 Population Estimation Survey

We surveyed 50 (20 low and 30 high density; 281 mi^2) of 169 SUs (951 mi^2) in the MFMA during 24–30 October using the methods described above.

Search intensity averaged 7.6 min/mi^2, slightly less than the recommended 8–10 min/mi^2. The Minto Flats received adequate snowfall for surveys by the third week of October and additional snow fell periodically throughout the remainder of the month. Survey conditions (Gasaway et al. 1986) with regard to snow (age and cover), light (intensity and type), and wind (strength and

turbulence) were primarily good (93%) with the remainder fair (4%) or poor (2%). Turbulence was not a factor during surveys.

2001 Population Estimation Survey

We surveyed 138 (54 low- and 84 high-density; 780 mi^2) of 1628 SUs (9196 mi^2) in Unit 20B on 6–26 November 2001 using the methods described above. Search intensity averaged 7.8 min/mi^2, slightly less than the recommended 8–10 min/mi^2. Survey conditions with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence) were reported primarily as fair (34%) and good (46%) with the remainder reported as excellent (13%) or poor (7%). Snow conditions tended to deteriorate as the survey period progressed. Turbulence was not a factor, although surveys were suspended several days due to high or turbulent winds.

Twinning Rate Surveys

Twinning rates were estimated from surveys conducted in traditional twinning survey trend count areas on the Minto Flats. Surveys consisted of roughly parallel transects flown at approximately ½-mile intervals at ≤500 feet AGL in PA-18 or Scout aircraft by experienced contract pilots. All moose observed were classified as bull, yearling cow, adult cow without a calf, or adult cow with single, twin or triplet calves. Twinning rate surveys were flown for 5.0 hr on 30 and 31 May 2000, 3.25 hr on 31 May 2001 and 4.8 hr on 29 May 2002. We terminated surveys and excluded the data if <15% of the cows had calves. For statistical reasons, we established, a priori, a minimum sample size of 50 cows with calves. Twinning rate was calculated as the proportion of cows with twins or triplets from the sample of all cows with calves.

MORTALITY

We estimated harvest based on harvest report cards. This included data from report cards from the general season, the FMA drawing hunt, and the MFMA Tier II permit hunt. Reminder letters were sent to nonreporting general season hunters, and up to 2 letters were sent to permit holders who failed to report. When antler size of bulls was reported, we considered bulls with antler spreads of <30 inches to be yearlings. Harvest data were summarized by regulatory year.

We estimated accidental mortality from Department of Public Safety records of collisions with motor vehicles and Alaska Railroad records of collisions with trains.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The 2001 population estimate for Unit 20B was 10,261 moose (8517–12,005; 90% CI) or about 1.1 moose/mi^2. However, because snow conditions for surveys were marginal the estimate may have been low. Even so, it is not likely we met the Intensive Management population objective established by the Board of Game for Unit 20B of 12,000–15,000 moose.

Prior to 2001, a unitwide population estimate had not been conducted since 1990 (McNay 1993). The population at that time was estimated at 9800 moose or about 1.1 moose/mi^2. Error bounds could not be calculated for that estimate because it included extrapolation; thus, the 1990 and 2001 estimates cannot be statistically compared. However, moose densities appeared similar between years.

Estimated moose densities were higher in Unit 20B West than in Units 20B Central or 20B East (Table 1). High moose density in the MFMA (1.9 moose/mi^2) likely influenced the overall Unit 20B estimate. Moose densities in Unit 20B West outside the MFMA were probably similar to densities observed throughout the remainder of Unit 20B. In Unit 20B Central, estimated densities were lower in 2001 (1.0 moose/mi^2) than in 1990 (1.2 moose/mi^2; McNay 1993) and 1994 (1.3 moose/mi^2). In contrast, estimated moose densities in Unit 20B West were higher in 1999 and 2001 (1.3–1.4 moose/mi^2) than in 1990 (0.9 moose/mi^2; McNay 1993).

Moose densities in the MFMA appeared to increase between 1989 (1.65 moose/mi^2; McNay 1993) and mid 1990s and then decline thereafter (Table 1). Productivity and early calf survival estimates support this observation. For instance, calf:100 cow ratios declined from 47:100 in 1994 and 1996 to 28:100 in 2001. Despite the apparent declines observed in the late 1990s, moose densities remained relatively high. Gasaway et al. (1992) reported that areas of Interior Alaska and the Yukon have densities of 0.1–1.0 moose/mi^2 where predators are lightly harvested. Higher densities occurred where wolves and/or bears were below food-limited levels.

Lower densities observed in 1999 and 2001 were likely artifacts of low survey intensity (1999) and marginal snow conditions (2001). As a result, actual moose densities in the MFMA during those years were likely higher than estimated and probably exceeded 2 moose/mi^2. However, surveys in the MFMA also may have been influenced by changes in moose distribution, due to the migratory nature of moose in the area (P Valkenburg and R Boertje, ADF&G, personal observation). Therefore, inconsistent results may occur regardless of sampling effort. This problem was exacerbated because of the relatively small size of the survey area. In addition, surveys were not directly comparable across years. For instance, the 1996 survey included 898 mi^2; whereas, the 1997 survey included 967 mi^2, of which most of the additional area (7.7%) included habitat with lower moose densities. Furthermore, the 1999 and 2001 surveys (951 mi^2) used the GSPE method, whereas previous surveys used Gasaway et al. (1986) methodology.

Moose densities in the FMA followed a trend similar to that observed in the MFMA (i.e., a decline in densities, productivity and early calf survival between the mid 1990s and 2001; Table 1). However, density in the FMA remained high, approaching or exceeding 1.5 moose/mi^2 since at least 1993.

I am uncertain whether the apparent trends in density, productivity and early calf survival observed in the MFMA and FMA occurred throughout Unit 20B because unitwide surveys were conducted too infrequently to evaluate long-term trends in the data.

Population Composition

Bull:Cow Ratios. In 1990, McNay (1993) estimated the overall Unit 20B bull:cow ratio averaged 40:100, well above the management objective of ≥30:100. The ratios varied by harvest intensity

within the unit. For instance, the less intensively harvested Salcha River and Minto Flats had bull:cow ratios of 44:100 (1990) and 49:100 (1989), respectively, and the MFMA had 47:100 in 1994 (Table 1). In contrast, the more intensively harvested Chena River had 28:100 (1990), and the most intensively harvested FMA had 9–14:100 (1989–1994).

Surveys conducted in 2001 indicate we met our management objective of a posthunting sex ratio of ≥30 bulls:100 cows unitwide and ≥20 bulls:100 cows in each count area (i.e., Unit 20B East, Unit 20B Central, Unit 20B West, and MFMA), except in the FMA (Table 1).

Bull:cow ratios in the FMA have been low (≤15:bulls:100 cows) since the early 1990s (Table 1). Hunting pressure was intense during fall prior to surveys, and most bulls killed are yearlings. Low yearling bull:cow ratios observed during November surveys (e.g., 4:100 in 1993, 3:100 in 1994, 7:100 in 2001) resulted largely from the high proportion of yearling bulls killed in September, and did not reflect poor calf recruitment. For example, we observed 39 calves:100 cows in 2001.

Calf:Cow Ratios. In general, calf:cow ratios declined between the mid 1990s and 2001 (Table 1). Calf:cow ratios tended to be higher in Unit 20B Central than Units 20B East and 20B West. The lowest ratios were observed in Unit 20B East (2001) and the highest were in the FMA (1994 and 1996). This is probably a function of lower predation rates in the FMA due to low predator abundance and poorer habitat in Unit 20B East.

Twinning Rates

Twinning rates in the MFMA appeared to decline dramatically between 1997 and 2001 (Table 2). Higher estimates in 1997 and 1998 may be an artifact of low sample sizes, although the apparent decline in the MFMA was consistent with a similar decline observed on the Tanana Flats in Unit 20A, where twinning rates fell from 18% in 1996 to 3% in 1999 (Young 2000). Twinning rates improved in 2002.

Distribution and Movements

Moose are distributed throughout Unit 20B, consisting of nonmigratory and migratory subpopulations (Gasaway et al. 1983). From February to April, some bull and cow moose migrate from the Chena and Salcha River drainages to calving areas on the Tanana Flats in Unit 20A. They remain there for the summer and return to the foothills from August through October. Although we do not know what proportion of the moose migrate, Gasaway et al. (1983) estimated that seasonal migrants probably increase the density of moose on the Tanana Flats 2- to 4-fold. Therefore, the summer densities in Unit 20B are probably much lower than during winter.

MORTALITY

Harvest

Season and Bag Limit. Seasons and bag limits in Unit 20B during RY99 were:

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Fairbanks Management Area.		
1 antlerless moose by bow and arrow by drawing permit, or	1 Sep–30 Sep	1 Sep–30 Sep
1 bull with antlers by bow and arrow.	1 Sep–30 Sep 21 Nov–27 Nov	1 Sep–30 Sep 21 Nov–27 Nov
Minto Flats Management Area.		
1 moose by Tier II permit only; or	1 Sep–20 Sep 10 Jan–28 Feb	No open season
1 bull with spike-fork or 50-inch antlers, or with at least 4 brow tines on 1 side.	11 Sep–20 Sep	No open season
Middle Fork drainage of Chena River, and Salcha River drainage upstream from and including Goose Creek.		
1 bull.	1 Sep–20 Sep	1 Sep–20 Sep
Remainder of Unit 20B.		
1 bull.	1 Sep–15 Sep	5 Sep–15 Sep

Seasons and bag limits in Unit 20B during RY00 were:

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Fairbanks Management Area.		
1 antlerless moose by bow and arrow by drawing permit; or	1 Sep–30 Sep 21 Nov–27 Nov	1 Sep–30 Sep 21 Nov–27 Nov

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
1 bull with antlers by bow and arrow.	1 Sep–30 Sep 21 Nov–27 Nov	1 Sep–30 Sep 21 Nov–27 Nov
Minto Flats Management Area.		
1 moose by Tier II permit only; or	1 Sep–20 Sep 10 Jan–28 Feb	No open season
1 bull with spike-fork or 50-inch antlers, or with at least 4 brow tines on 1 side.	11 Sep–20 Sep	No open season
Middle Fork drainage of Chena River, and Salcha River drainage upstream from and including Goose Creek.		
1 bull.	1 Sep–20 Sep	1 Sep–20 Sep
Remainder of Unit 20B.		
1 bull.	1 Sep–15 Sep	5 Sep–15 Sep

In RY95, 60 MFMA Tier II permits could be issued. The number of Tier II permits was increased to 100 in RY96 and has remained at 100 through RY00.

Alaska Board of Game Actions and Emergency Orders.

Historical Board of Game Actions — In the MFMA, the department issued 150 Tier II permits per year from RY90 through RY92 to provide for an annual harvest quota of 50 bulls. However, harvests were only 28–42 per year. In spring 1993 we calculated a new harvest quota of 100 bulls and recommended the Alaska Board of Game authorize up to 250 permits. The board passed our recommendation and the department issued 200 permits in RY93 and RY94. In spring 1995 the board approved changes for the MFMA and FMA. The Tier II bag limit was changed from any bull to any moose and the number of permits was reduced to 60. A general hunt was added for bulls with spike-fork or 50-inch antlers or antlers with 4 or more brow tines with a shorter season than the Tier II hunt. The MFMA general season was further reduced in RY96. The board also approved a drawing hunt for antlerless moose in the FMA beginning in RY95 and replaced the registration hunt with a general season.

Spring 2000 Board of Game Actions — In RY00, the FMA was enlarged from approximately 217 mi^2 to 318 mi^2 to clarify boundaries in the Cripple Creek and Goldstream areas and to address safety issues in developed areas in the Goldstream Valley and Chena Hot Springs Road/Nordale areas. The number of FMA antlerless moose permits that could be issued was increased from 25 to 100 in response to high moose densities and the increasing number of

moose–vehicle collisions and moose–human conflicts in the Fairbanks area. Also, the FMA antlerless moose hunt was liberalized to include a 21–27 November season to align the bull and antlerless seasons, increase the harvest of cows, and provide additional hunting opportunity.

In November 2000 the Board of Game adopted Intensive Management (IM) population (12,000–15,000 moose) and harvest (600–1500 moose) objectives for Unit 20B.

Spring 2002 Board of Game Actions — During the spring 2002 meeting, the board modified the boundaries of the FMA in the Cripple Creek, Fox, and Steele Creek areas; added a 21–30 September hunt by bow and arrow only in the drainage of the Middle (East) Fork of the Chena River and Salcha River upstream from and including Goose Creek; and created a 3–6 August youth (8–17 years of age) hunt for any bull in Unit 20B, excluding the FMA and MFMA.

Hunter Harvest.

General Season — Reported harvests during general season hunts increased from 426 bulls in RY94 to 679 in RY98 (Table 3). The increase was due largely to expanded opportunity created by added general seasons, increased hunting effort, and increasing moose numbers. Reported harvest declined in RY99 and RY00. Those trends were apparent in the MFMA, but not the FMA. Reported harvest in the MFMA increased from 18 to 57 bulls annually (RY94–RY98), then dropped to 47 bulls in RY00. However, in the FMA, harvest was relatively stable (35–48 bulls annually), except for RY95 when harvests were lower.

The majority of harvest was in Unit 20B Central followed by Unit 20B West and then Unit 20B East (Table 3). Harvest density in Unit 20B Central was roughly 2.5 times that reported in Units 20B East and 20B West. As stated above regarding calf:cow ratios, this is likely a function of higher moose densities due to lower predator densities and better habitat in Unit 20B Central than in Unit 20B West and 20B East.

Drawing Permit Hunts — In the antlerless hunt DM788, success rates increased 14% between RY96 and RY98 (Table 4). Similarly, success rates improved in hunt TM785, but to a lesser extent (9% RY96–RY98). No trends were apparent in success rates from RY98 through RY01 in hunts DM788 or TM785.

Hunter Residency and Success. Primarily local residents hunted moose in Unit 20B (Table 3). Participation by nonlocal residents and nonresidents was relatively low.

Hunter success during the general season was generally lower in Unit 20B than elsewhere in Unit 20. For example, annual success rates in Units 20A and 20C typically exceed 35% (Young 2000). Between RY94 and RY00, 15–23% of the hunters in Unit 20B were successful (Table 3). During RY99 and RY00, success rates were within the range observed in RY94 through RY98. Unit 20B Central had lower success rates ($\bar{x}$ = 19%) than Units 20B West ($\bar{x}$ = 23%) and Unit 20B East ($\bar{x}$ = 28%). Typically, success rates are lower in areas with higher hunter densities and/or lower bull:cow ratios, such as Unit 20B Central, and higher in areas with lower hunter densities and/or higher bull:cow ratios, such as Unit 20B East.

In the FMA, harvests were relatively high during the past 8 years (Young 2000; this report). The high harvests were likely the result of high densities and survival rates of moose in the FMA during that period. Population estimates and anecdotal information indicate that moose densities, productivity, and early calf survival were high in the FMA between 1993 and 2001 (Table 1).

Harvest Chronology. Between RY97 and RY00, more bull moose were killed during the first 5 days of the season than during any other 5-day period (Table 5). Although data are preliminary, the 11–15 September period ranked highest in RY01.

Transport Methods. Highway vehicles were the primary method of transportation used by successful hunters (Table 6). Since RY97 the proportion of successful hunters using 3- or 4-wheelers and boats (traditional and airboats) increased slightly, while the proportion using highway vehicles and airplanes declined somewhat. No other trends were apparent.

Other Mortality

The number of moose killed in accidents with motor vehicles and trains has been substantial in some years (Table 7). The number of moose reported killed on highways in the FMA approached or exceeded 100 animals annually in RY97 through RY00. By comparison, only 53–75 moose were reported harvested annually by hunters in the FMA during that period. An additional 52–75 moose were killed each year on roads in the remainder of Unit 20B. Few moose were reported killed by trains during RY97 through RY00, with the exception of RY99 when 61 were reported killed.

HABITAT

Assessment/Enhancement

The department is planning and/or conducting moose habitat enhancement for portions of the Fairbanks area. These efforts include use of prescribed fire and regeneration of decadent willows by planting willows in recently logged areas. In addition, existing habitat improvement projects for grouse in Unit 20B have positive benefits for moose.

The proposed Nenana Basin Gas Lease could potentially fragment important moose habitat in the Minto Flats area. Development could affect moose in 2 ways. First, pipelines and roads may improve access. More importantly, increased fire suppression near wells and structures may adversely affect habitat capability for moose. The Division of Wildlife Conservation forwarded these concerns via comments submitted in response to the Alaska DNR, Division of Oil and Gas Preliminary Best Interest Finding.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

We have been collecting more systematic information on nonhunting mortality of moose because of its potential influence on harvest quotas and population trends. Motor vehicle and railroad kills continue to be an important source of mortality (Table 7). Within the Fairbanks urban area, we also receive a considerable number of complaints about human–moose conflicts, such as moose in gardens or yards, moose attacking dogs along dogsled trails, and moose "trapped" within the confines of the urban area. For instance, in RY00 the department received 129 complaints involving moose within Unit 20B. Department policy for the treatment of nuisance

moose should be formalized for public consideration. Mitigation measures, including public education, are continuing.

CONCLUSIONS AND RECOMMENDATIONS

Surveys conducted in 2001 indicate we met our management objective of a posthunting sex ratio of ≥30 bulls:100 cows unitwide and ≥20 bulls:100 cows in each count area (i.e., Unit 20B East, Unit 20B Central, Unit 20B West, and MFMA), except in the FMA. Low bull:cow ratios in the FMA, a relatively small area, are of less concern than in larger areas because the FMA is small in relation to the annual home range of moose. If there are not enough bulls available in the FMA for breeding, cows in estrous can easily move to the periphery or outside the FMA where bull:cow ratios are higher, and bulls seeking females can readily immigrate into the FMA. High calf:cow ratios (Table 1) also indicate there have been sufficient bull moose in the FMA to breed cows in estrous. As a result, in the next reporting period the FMA will be deleted from the management objective mandating ≥20 bulls:100 cows in each count area.

We did not meet the IM population objective established for Unit 20B by the Board of Game, although the population likely approached the lower limit of 12,000 moose. Estimated harvest exceeded the IM harvest objective lower limit of 600 moose.

I concur with Dale (1998) that we need to collect unitwide population data on an annual basis to better assess the status of the population, then reevaluate management objectives, and gain public approval of those management objectives.

LITERATURE CITED

DALE B.W. 1998. Unit 20B moose management progress report of survey–inventory activities. Pages 288–299 *in* MV Hicks, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grants W-24-4 and W-24-5. Study 1.0. Juneau, Alaska.

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.

———, S.D. DUBOIS, D.J. REED, AND S.J. HARBO. 1986. Estimating moose population parameters from aerial surveys. Biological Paper 22. University of Alaska Fairbanks.

———, R.D. BOERTJE, D.V. GRANGAARD, D.G. KELLYHOUSE, R.O. STEPHENSON, AND D.G. LARSEN. 1992. The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. *Wildlife Monographs* 120.

MCNAY M.E. 1993. Units 20B and 25C moose management progress report of survey–inventory activities. Pages 244–266 *in* SM Abbott, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grants W-23-3 and W-23-4. Study 1.0. Juneau, Alaska.

VER HOEF J.M. 2001. Predicting finite populations from spatially correlated data. 2000 Proceedings of the Section on Statistics and the Environment of the American Statistical Association. pp 93–98.

YOUNG D.D. 2000. Unit 20A moose management progress report of survey–inventory activities. Pages 300–318 *in* MV Hicks, editor. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grants W-27-1 and W-27-2. Study 1.0. Juneau, Alaska.

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Table 1 Unit 20B aerial moose fall composition counts and estimated population size, regulatory years 1993–1994 through 2001–2002

Count area	Regulatory year	Bulls:100 Cows	Yearlings: 100 Cows[a]	Calves:100 Cows	Percent calves	Adults	Moose observed	Moose/mi^2	Estimated population size (90% CI)
Unit 20B	2001–2002	33	15	30	18	751	914	1.1[b]	10261 (±17%)
Unit 20B East[c]	2001–2002	47	15	24	11	271	305	1.0[b]	2454 (±22%)
Unit 20B Central[d]	1994–1995	18	5	47	28		428	1.3[e]	
Unit 20B Central[f]	2001–2002	27	13	34	26	205	278	1.0[b]	4005 (±25%)
Unit 20B West[g]	1999–2000	27	14	34	20	438	546	1.4[b]	4881 (±20%)
Unit 20B West[h]	2001–2002	30	16	29	17	274	331	1.3[b]	3802 (±22%)
MFMA[i,j]	1994–1995	47	11	47	24		489	2.9[k]	
MFMA[j]	1996–1997	27	27	47	27			3.0[l]	2627 (±14%)
MFMA[m]	1997–1998	33	15	34			647	2.7[l]	2604 (±45%)
MFMA[n]	1999–2000	31	16	36	19	374	463	1.9[b]	1778 (±20%)
MFMA[n]	2000–2001	31	8	39	24	546	714	2.4[b]	2200 (±14%)
MFMA[n]	2001–2002	30	16	28	17	191	230	1.9[b]	1877 (±21%)
FMA[o,p]	1993–1994	9	8	30	27		65	1.3	
FMA[q]	1994–1995	14	6	61	40		165	2.6[e]	
FMA[q]	1996–1997	15	23	52	32	101	150	1.9	
FMA[r]	2001–2002	12	13	39	28	70	99	1.4[b]	461 (±34%)

[a] Yearlings:100 cows = Yearling bulls:100 cows × 2.
[b] Geostatistical Population Estimation method does not incorporate a SCF (see methods).
[c] A 2425-mi^2 count area.
[d] A 642-mi^2 count area north and west of Fairbanks.
[e] Corrected for sightability (SCF = 1.23).
[f] A 3829-mi^2 count area.
[g] A 3644-mi^2 count area encompassing most of Unit 20B West (3955 mi^2), including the MFMA.
[h] A 2942-mi^2 count area.
[i] Minto Flats Management Area.
[j] An 898-mi^2 count area.
[k] Corrected for sightability (SCF = 1.13).
[l] Corrected for sightability (SCF = 1.18).
[m] A 967-mi^2 count area.
[n] A 951-mi^2 count area.
[o] Fairbanks Management Area.
[p] A 52-mi^2 count area within the FMA.
[q] A 78-mi^2 count area within the FMA.
[r] A 318-mi^2 count area.

Table 2 Results of twinning rate surveys for moose in Unit 20B (Minto Flats Management Area), 1997–2002

		Cows			
Year	Date	w/Single calf	w/Twins	Total	% Twins[a]
1997	22 May	17	9	26	35
1998	31 May	18	5	23	22
1999	27–29 May	59	4	63	6
2000	30–31 May	74	10	84	12
2001	31 May	58	5	63	8
2002	29 May	38	10	48	21

[a] Percentage of cows with calves that had twins.

Table 3 Unit 20B moose hunter[a] residency and success, regulatory years 1994–1995 through 2001–2002

Area/ Regulatory year	Successful						Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	% Successful	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	
Unit 20B East (UCUs 601, 602, 603, 604, 605)												
1999–2000	70	12	6	1	89	27	214	17	10	2	243	332
2000–2001	76	14	9	0	99	28	222	20	9	0	251	350
2001–2002[c]	51	3	8	0	62	20	211	18	15	3	247	309
Unit 20B Central (UCUs 207, 208, 209, 211, 212, 213, 301, 401, 402, 403, 404, 405, 406, 501)												
1999–2000	281	22	25	2	330	19	1263	74	77	7	1421	1751
2000–2001	269	30	28	0	327	19	1257	75	90	8	1430	1757
2001–2002[c]	263	14	23	3	303	19	1131	82	87	5	1305	1608
Unit 20B West (UCUs 101, 201, 202, 203, 204, 205, 206, 210)												
1999–2000	92	14	8	0	114	26	269	41	19	2	331	445
2000–2001	69	17	5	1	92	19	305	59	28	2	394	486
2001–2002[c]	58	17	9	0	84	20	238	66	23	2	329	413
FMA general archery hunt (UCUs 0212, 0213, 0300, 0301, 0401, 0402, 0403, 0501; archery only)												
1994–1995	45	0	0	0	45	11	332	26	4	0	363	407
1995–1996	27	0	1	1	29[d]							
1996–1997	41	1	1	1	44[d]							
1997–1998[e]	44	0	0	0	44[d]							
1998–1999[e]	35	1	1	0	37[d]							
1999–2000[e]	35	0	0	0	35[d]							
2000–2001[f]	46	1	1	0	48[d]							
2001–2002[c,f]	44	1	1	0	46							
MFMA general hunt (UCUs 0201, 0205, 0210; Nonresident hunters and antlerless harvest censored)												
1994–1995	16	2	0	0	18	19	66	11	0	1	78	96
1995–1996	32	2	0	0	34	23	105	10	0	1	116	150
1996–1997	35	3	0	1	39	37	59	8	0	0	67	106
1997–1998	37	7	0	0	44	39	65	4	0	0	69	113
1998–1999	44	12	0	1	57	32	112	6	0	1	119	176
1999–2000	43	5	0	0	48	27	119	10	0	1	130	178
2000–2001	40	6	0	1	47	28	109	13	0	0	122	169
2001–2002[c]	26	9	0	1	36	27	77	18	0	1	96	132

Area/ Regulatory year	Successful						Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	% Successful	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	
Unit 20B remainder general hunt (Includes FMA general archery hunt, but excludes MFMA)												
1994–1995	362	16	27	3	408	15	2132	122	88	21	2363	2771
1995–1996	419	42	36	5	502	21	1684	104	111	20	1919	2421
1996–1997	489	45	46	2	582	21	1927	105	124	8	2164	2746
1997–1998	446	31	34	2	513	19	1925	124	92	20	2161	2674
1998–1999	529	44	46	3	622	22	1943	131	123	17	2214	2836
1999–2000	457	46	47	4	554	20	1907	156	113	13	2189	2743
2000–2001	433	69	43	1	546	20	1866	162	134	17	2179	2725
2001–2002[c]	384	33	43	3	463	18	1776	185	140	9	2110	2573
All general hunts												
1994–1995	378	18	27	3	426	15	2198	133	88	22	2441	2867
1995–1996	451	44	36	5	536	21	1789	114	111	21	2035	2571
1996–1997	524	48	46	3	621	22	1986	113	124	8	2231	2852
1997–1998	483	38	34	2	557	20	1990	128	92	20	2230	2787
1998–1999	573	56	46	4	679	23	2055	137	123	18	2333	3012
1999–2000	500	51	47	4	602	21	2026	166	113	14	2319	2921
2000–2001	473	75	43	2	593	20	1975	175	134	17	2301	2894
2001–2002[c]	410	42	43	4	499	18	1853	203	140	10	2206	2705

[a] Excludes drawing and Tier II permit hunt harvest.
[b] Residents of Unit 20.
[c] Preliminary data.
[d] Subtracted number of bulls reported harvested by bow and arrow on Eielson AFB (in UCU 0501, but outside FMA).
[e] FMA approx. 230 mi^2.
[f] FMA approx. 330 mi^2.

Table 4 Unit 20B moose harvest data by permit hunt, regulatory years 1996–1997 through 2001–2002

Hunt	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Bulls (%)	Cows (%)	Unk (%)	Harvest
DM788	1996–1997	15	1 (7)	7 (50)	7 (50)	0 (0)	7 (100)	0 (0)	7
	1997–1998	25	2 (8)	9 (39)	14 (61)	0 (0)	14 (100)	0 (0)	14
	1998–1999	25	0 (0)	9 (36)	16 (64)	0 (0)	16 (100)	0 (0)	16
	1999–2000	25	2 (8)	12 (52)	11 (48)	0 (0)	11 (100)	0 (0)	11
	2000–2001	50	5 (10)	18 (40)	27 (60)	0 (0)	27 (100)	0 (0)	27
	2001–2002	75	13 (17)	34 (55)	28 (45)	2 (7)	26 (93)	0 (0)	28
TM785	1996–1997	100	20 (20)	30 (38)	50 (62)	27 (54)	23 (46)	0 (0)	50
	1997–1998	100	17 (17)	30 (36)	53 (64)	30 (57)	23 (43)	0 (0)	53
	1998–1999	100	17 (17)	24 (29)	59 (71)	32 (54)	27 (46)	0 (0)	59
	1999–2000	100	22 (22)	21 (27)	57 (73)	34 (60)	23 (40)	0 (0)	57
	2000–2001	100	15 (15)	31 (36)	54 (64)	28 (52)	25 (46)	1 (2)	54
	2001–2002	100	17 (17)	26 (31)	57 (69)	31 (54)	26 (46)	0 (0)	57
Totals for all permit hunts	1996–1997	115	21 (18)	37 (39)	57 (61)	27 (47)	30 (53)	0 (0)	57
	1997–1998	125	19 (15)	39 (37)	67 (63)	30 (45)	37 (55)	0 (0)	67
	1998–1999	125	17 (14)	33 (31)	75 (69)	32 (43)	43 (57)	0 (0)	75
	1999–2000	125	24 (19)	33 (33)	68 (67)	34 (50)	34 (50)	0 (0)	68
	2000–2001	150	20 (13)	49 (38)	81 (62)	28 (35)	52 (64)	1 (1)	81
	2001–2002	175	30 (17)	60 (41)	85 (59)	33 (39)	52 (61)	0 (0)	85

Table 5 Unit 20B moose harvest[a] chronology percent by month/day, regulatory years 1997–1998 through 2001–2002

Regulatory year	Harvest chronology percent by month/day						
	9/1–9/5	9/6–9/10	9/11–9/15	9/16–9/20	9/21–9/25	Unk/Other	*n*
1997–1998	33	25	27	6	3	6	557
1998–1999	35	25	28	6	1	4	679
1999–2000	33	25	30	7	1	4	602
2000–2001	37	22	28	6	2	5	593
2001–2002[b]	27	26	32	5	2	8	499

[a] Excludes drawing and Tier II permit hunt harvest.

[b] Preliminary data.

Table 6 Unit 20B moose harvest[a] percent by transport method, regulatory years 1997–1998 through 2001–2002

Regulatory year	Harvest percent by transport method									
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Other/ Unknown	Airboat	*n*
1997–1998	5	0	18	26		5	42	3	1	557
1998–1999	3	0	20	30		3	41	2	2	679
1999–2000	3	1	19	29	0	4	39	3	2	602
2000–2001	3	0	21	29	0	4	35	4	3	593
2001–2002[b]	3	0	21	31	0	4	35	2	3	499

[a] Excludes drawing and Tier II permit hunt harvest.

[b] Preliminary data.

Table 7 Estimate of Unit 20B moose harvest[a] and accidental death, regulatory years 1997–1998 through 2001–2002

	Harvest by hunters							Accidental death					
	Reported				Estimated			Road[b]					
Regulatory year	M	F	Unk	Total	Unreported[c]	Illegal/ Other[d]	Total	FMA[e]	Unit 20B remainder	Total	Train[f]	Total	Total
1997–1998	586	37	1	624	110	79	189	97	70	167	15	182	995
1998–1999	709	43	2	754	133	65	198	93	73	166	13	179	1131
1999–2000	624	34	12	670	119	96	215	117	75	192	61	253	1138
2000–2001	611	31	9	651	115	44	159	105	52	157	7	164	974
2001–2002[g]	522	55	6	583	103	26	129	43[h]	32[h]	75[h]	8[i]	83[g]	795[g]

[a] Includes general and permit hunt harvest.
[b] Documented kills; actual number killed by vehicles is certainly greater.
[c] Based on 17.7% unreported harvest (including wounding loss) estimated by Gasaway et al. (1992).
[d] Includes illegal, DLP, dispatched, potlatch, stickdance, and other reported deaths.
[e] Fairbanks Management Area.
[f] Confirmed dead between Alaska Railroad mileposts 411.8 and 470.0; "Missing" (moose hit but not recovered) are not included. Data provided by the Alaska Railroad.
[g] Preliminary data.
[h] Number of moose killed through December 2001.
[i] Number of moose killed through April 2002.

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MOOSE MANAGEMENT REPORT

From: 1 July 1999
To: 30 June 2001

LOCATION

GAME MANAGEMENT UNIT: 20C (11,902 mi^2), 20F (6267 mi^2), and 25C (5149 mi^2)

GEOGRAPHIC DESCRIPTION: Unit 20C includes drainages into the west bank of the Nenana River, and into the south bank of the Tanana River west of the Nenana River. Most of Denali National Park and Preserve is within Unit 20C. Unit 20F includes drainages into the north bank of the Tanana River west of Manley, and into the Yukon River approximately between the village of Tanana and the Dalton Highway bridge. Unit 25C includes drainages into the south bank of the Yukon River upstream from Circle to, but not including the Charley River drainage. The subunit also includes the Birch Creek drainage upstream from the Steese Highway bridge, the Preacher Creek drainage upstream from and including the Rock Creek drainage, and the Beaver Creek drainage upstream from and including the Moose Creek drainage.

BACKGROUND

Moose densities in Units 20C, 20F, and 25C have been low for many years, presumably because of combined predation from wolves and bears (Gasaway et al. 1992) and habitat limitations. Wolf and bear populations are lightly harvested. Bull moose harvest is low relative to population size, and the proportion of large bulls in the harvest remains relatively high. Therefore, harvest is a minor factor affecting population dynamics relative to predation.

These subunits contain large tracts of mature black spruce that are poor quality moose habitat. However, many riparian areas, subalpine hills, and old burns appear to have habitat capable of supporting moose at relatively high densities (≥2 moose/mi^2).

Trends in moose populations have been difficult to identify, but densities probably fluctuate within 0.1 and 1 moose/mi^2 based on Alaska and Yukon studies in areas with 2 or more lightly-harvested predators (Gasaway et al. 1992).

Moose within Denali National Park and Preserve (DNPP) have been studied more intensively than moose in the rest of the subunits. These studies include movement and behavior of radiocollared moose, composition surveys, and population estimates conducted by DNPP biologists since 1970.

Moose are an important source of food for many local rural residents. In addition, people throughout the Interior hunt moose in these subunits for food and/or trophies.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Provide for a sustained harvest of these low-density populations.
- Promote moose habitat enhancement by allowing natural fires to alter vegetation.

MANAGEMENT OBJECTIVE

- Maintain a bull:cow ratio of 30:100.

METHODS

A Geostatistical Population Estimator (GSPE; Ver Hoef 2001) was completed in Unit 25C (5000 mi^2) during November–December 1997. A census using Gasaway methods (Gasaway et al. 1986) was conducted during November 1994 by DNPP biologists in the Lake Minchumina Area (1007 mi^2) of Unit 20C. Stratification flights associated with the GSPE technique were completed for that portion of Unit 20C outside of DNPP on 19 December 2000 and a GSPE census is scheduled for November 2002.

We estimated annual moose mortality using data from harvest report cards (after sending reminder letters to increase response), and using calls to our office concerning nonhunting mortality of moose, records of moose/motor vehicle collisions (Fish and Wildlife Protection log sheets), and Alaska Railroad records of moose/train collisions between railroad mile posts 327–371 in Unit 20C. Data were summarized by regulatory year (RY), which begins 1 July and ends 30 June (e.g., RY00 = 1 Jul 2000–30 Jun 2001).

In 1987 a Subsistence Division study was conducted to assess wild resource use in the village of Tanana. This study was used to estimate unreported harvest.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

We estimated 3500–4500 moose inhabited Unit 20C; 2000 within Denali National Park and 1500–2500 outside Denali National Park (including Denali National Preserve). These estimates assumed an average density of 0.58 moose/mi^2 inside Denali National Park (October 1991 census; T Meier, personal communication) and 0.25 moose/mi^2 outside Denali National Park.

During a November 1994 survey of the Lake Minchumina area, Denali Park biologists estimated the density at 0.34 moose/mi^2 (K Stahlnecker, personal communication). Budget requests for RY02–RY03 include funds to conduct a GSPE survey in Unit 20C outside DNPP.

We estimated 1000–2000 moose resided in Unit 20F. This assumed 0.25–0.50 moose/mi^2, with roughly 4250 mi^2 of moose habitat (McNay 1990).

The density estimate for Unit 25C was 0.46 moose/mi^2 based on the 1997 GSPE, with a total population estimate of 2279 moose (90% CI ±16.5%). This low estimate was expected because nearly half the subunit contains mountainous non-moose habitat or open mountainous tundra interspersed by small drainages with localized, good moose habitat. The 1997 estimate was a cooperative effort between the Bureau of Land Management (BLM) and the Alaska Department of Fish and Game (ADF&G).

Population Composition

Population composition data in Units 20C and 20F were limited to the percentage of large bulls in the harvest (Fig 1). The percentage of large bulls in the reported harvest has been relatively stable in Unit 20C since 1995 (30–40%) and variable in Unit 20F (24–55%). A possible reason for the variability in Unit 20F is a small annual sample size (29–45). Results from the 1997 GSPE in Unit 25C included estimates of 53 bulls:100 cows and 37 calves:100 cows (Table 1). We conclude that harvest has minimal impact on these populations. If harvest rates of bulls were high, the percentage of large bulls in the harvest would decline within a few years.

Distribution and Movements

No movement data were collected in any of the units and no distribution data were collected in Unit 20F during this reporting period. Distribution data for the other 2 units were limited to the 1997 census in Unit 25C and the stratification flights in Unit 20C. In both areas moose were most abundant in the limited areas of good riparian habitat.

MORTALITY

Harvest

Season and Bag Limit. Hunting seasons and bag limits have not changed since RY93 (Table 2).

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 20C		
RESIDENT HUNTERS: 1 bull; however, white-phased or partial albino (more than 50% white) moose may not be taken.	1 Sep–20 Sep	
NONRESIDENT HUNTERS: 1 bull; however, white-phased or partial		5 Sep–15 Sep

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
albino (more than 50% white) moose may not be taken.		
Unit 20F, drained by the Yukon River excluding the Tanana River drainage downstream from the drainage of Hess Creek.		
RESIDENT HUNTERS: 1 bull.	1 Sep–20 Sep or 1 Dec–10 Dec	No open season
Unit 20F, drained by the Tanana River.		
RESIDENT HUNTERS: 1 bull.	1 Sep–20 Sep	No open season
Remainder of Unit 20F		
RESIDENT HUNTERS: 1 bull.	1 Sep–15 Sep	No open season
Unit 25C		
RESIDENT HUNTERS: 1 bull.	1 Sep–15 Sep	
NONRESIDENT HUNTERS: 1 bull.		5 Sep–15 Sep

Alaska Board of Game Actions and Emergency Orders. No Board of Game actions were taken and no emergency orders were issued during this reporting period.

Hunter Harvest. Recently, hunting pressure has increased in these units (Table 3). During RY97, 143 moose were reported killed by 382 hunters in Unit 20C, 29 moose were reported killed by 118 hunters in Unit 20F, and 57 moose were reported killed by 212 hunters in Unit 25C. In RY00, 130 moose were reported killed by 457 hunters in Unit 20C, 40 moose were reported killed by 166 hunters in Unit 20F, and 79 moose were reported killed by 323 hunters in Unit 25C. Harvest levels are near historic highs for Units 20F and 25C, but below historic highs in Unit 20C.

Nuchalawoyya Potlatch — In spring 1989 the Board of Game authorized the department to issue permits to take up to 3 moose/year for the Nuchalawoyya potlatch. No potlatch was held during RY97–RY98 and data for RY99–RY00 were not available when this report was written.

Federal Permit Hunt 790 — In RY92 the Federal Subsistence Board created a 1–25 September moose season on federal public land in Unit 20F for qualified local subsistence users by federal registration permit. The federal public land is located within the Dalton Highway corridor. In RY96, 2 permits were issued with 1 successful permittee. During RY97, 3 permits were issued, but no permittees hunted. During RY98 no permits were issued (C Miller, US Fish and Wildlife Service, personal communication, May 2000) and data for RY99–RY00 were not available when this report was written.

Harvest data for a federal hunt for RY99–RY00 in Unit 20C were not available when this report was written. Efforts will be made to obtain these data for the next reporting period.

Unreported Harvest and Estimated Nonhunting Mortality — The number of unreported kills in Units 20C, 20F, and 25C is not easily estimated. Harvest report card returns from Tanana, Rampart, Manley, Livengood, Central, Circle, and Circle Hot Springs within these subunits were minimal. For example, ADF&G's Division of Subsistence research information from the village of Tanana illustrates the magnitude of the nonreporting problem. They found that only 10–20% of the actual harvest for Tanana residents was reported. The reporting rate for other rural communities in this area is unknown.

Illegal, other, and motor vehicle deaths were obtained from the Fairbanks Fish and Wildlife Protection wildlife mortality logs. Data concerning deaths caused by train collisions (only applicable for Unit 20C) were obtained from the Alaska Railroad. Documented causes of accidental mortality were minimal (0–3 annually) in Unit 20F and Unit 25C, but higher in Unit 20C (4–21 annually) due to deaths caused by train collisions.

Hunter Residency and Success. The number of hunters in all units has increased during the last 5 years (RY96–RY00), while success rates decreased in Unit 20C, remained relatively stable in Unit 20F, and were variable but decreasing in Unit 25C (Table 3). During the last 5 years, 9% (292/3258) of the hunters reporting in Units 20C and 25C were nonresidents, and there were no nonresident seasons in Unit 20F. The 5-year average success rate for hunters was 33% (667/2003) in Unit 20C, 25% (177/699) in Unit 20F, and 27% (349/1273) in Unit 25C.

Most successful hunters in Units 20C, 20F, and 25C continued to be Alaska residents (Table 3). During RY99–RY00, 90% of the reported successful hunters in Unit 20C were Alaska residents, and about 75% in Unit 25C were Alaska residents. In addition, most successful hunters were "nonlocal" hunters, primarily from Fairbanks (Table 4).

Harvest Chronology. Since RY93 most reported harvest in all units was during the second week of the season, with the first and third weeks being similar, but at a lower level for Units 20C and 20F (Table 5).

Transport Methods. In Unit 20C most successful hunters used boats, airplanes, and 3- or 4-wheelers for transportation (Table 6). Extensive river systems, many lakes, gravel bars, and an expanding trail system make these transport methods most useful. In Unit 20F boats were the primary mode of transportation for successful hunters, and in Unit 25C successful moose hunters utilized highway vehicles, 3- or 4-wheelers, and boats. The transportation methods used throughout this area reflected access options.

HABITAT

BLM is reclaiming mine tailings within the White Mountains National Recreation Area in Unit 25C. Native willows are being planted to enhance the revegetation process and increase moose browse.

The most recent habitat improvements in these units have been associated with wildfire. For a history of wildfires in this area, refer to BLM's URL: ftp://borealis.ak.blm.gov/pub/gis/ and download file "firehist99.tar".

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

Harvest reporting in these subunits has been poor. We need to contact more people in remote areas to emphasize the importance and benefits of reporting harvest. It would be especially helpful to contact young people in the village schools to establish harvest reporting as a responsibility of all hunters and to promote the positive aspects of reporting.

Fire is an integral part of Interior ecosystems and is essential to producing good moose habitat in areas of climax spruce forests. We should continue to coordinate wildlife needs with fire suppression activities and encourage more controlled burns to enhance habitat. Eastern Unit 25C should be evaluated for its potential for a controlled burn. This area presently contains wide expanses of black spruce with only small areas of moose habitat.

Collisions with trains has been a significant mortality factor for moose in some areas of Unit 20C (Table 7). Efforts to reduce these mortalities should continue, and we need to establish better reporting and data management strategies when accidents do occur.

CONCLUSIONS AND RECOMMENDATIONS

Moose populations in Units 20C, 20F, and 25C are at low densities. Hunting pressure was relatively low, but increasing. Regulations in place during this reporting period addressed our current management objectives, and no regulatory changes are recommended at this time.

We met our objective to estimate hunting and nonhunting mortality, and we worked to gather information on reporting rate from rural communities so a more comprehensive total estimate of harvest could be produced.

We completed the stratification for Unit 20C outside of DNPP, but we did not initiate stratification of relative moose abundance in Unit 20F. We made progress on our goal to promote natural fires to enhance moose habitat through the department's efforts on the Interagency Fire Management Team.

LITERATURE CITED

GASAWAY W.C., S.D. DUBOIS, D.J. REED, AND S.J. HARBO. 1986. Estimating moose population parameters from aerial surveys. Biological Paper 22. University of Alaska Fairbanks.

———, R.D. BOERTJE, D.V. GRANGAARD, D.G. KELLEYHOUSE, R.O. STEPHENSON, AND D.G. LARSEN. 1992. The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. *Wildlife Monographs* 120.

MCNAY M.E. 1990. Units 20B and 25C moose management progress report of survey–inventory activities. Pages 239–259 *in* SO Morgan, editor. Alaska Department of Fish and Game.

Federal Aid in Wildlife Restoration. Volume XX. Part VIII. Grant W-23-2. Study 1.0. Juneau, Alaska.

VER HOEF J.M. 2001. Predicting finite populations from spatially correlated data. 2000 Proceedings of the Section on Statistics and the Environment of the American Statistical Association. pp 93–98.

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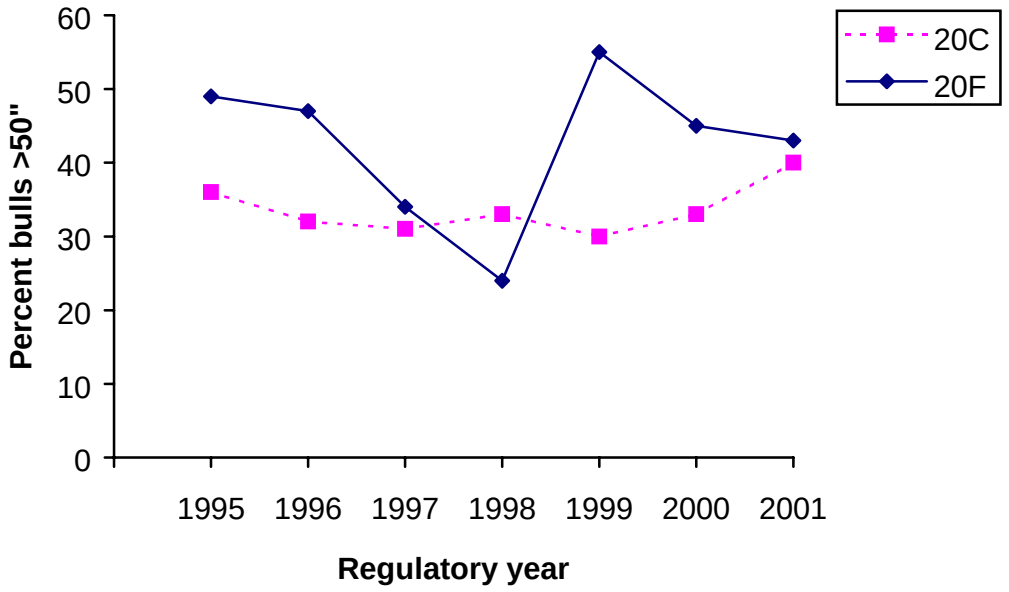

Figure 1 Percent of bull moose in the reported fall harvest with an antler spread >50 inches in Units 20C and 20F, regulatory years 1995–1996 through 1999–2000

Table 1 Unit 25C fall aerial moose composition counts, 1986–1997

Year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves: 100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/mi^2	Survey area size (mi^2)
1986[a]	103	13	21	8	9	77	85	1.49	57.0
1987[a]	77	11	28	13	14	83	96	1.68	57.0
1988[a]	129	37	33	16	13	112	128	2.25	57.0
1996[a]	119		11	3	5	57	60	1.05	57.0
1997[b]	53	13	37	80	20	319	399	0.46	5000

[a] O'Brien Creek count area.
[b] Geostatistical Population Estimator moose population estimate conducted 2 November 1997 through 3 December 1997.

Table 2 Units 20C, 20F and 25C moose hunting seasons, regulatory years 1990–1991 through 2001–2002

	Unit 20C		Unit 20F		Unit 25C	
Regulatory year	Season[a]	Hunters allowed[b]	Season	Hunters allowed[b]	Season	Hunters allowed[b]
1990–1991	1–15 Sep	R	1–15 Sep	R	1–15 Sep	R
	5–15 Sep	N[c]	1–10 Dec	R (Tier II)	5–15 Sep	N[c]
1991–1992	1–20 Sep	R	1–15 Sep	R	1–15 Sep	R
	5–15 Sep	N	1–10 Dec[d]	R	5–15 Sep	N
			1–25 Sep	FS[e]		
1992–1993	1–20 Sep	R	1–15 Sep	R	1–15 Sep	R
through	5–15 Sep	N	1–10 Dec[f]	R	5–15 Sep	N
2001–2002	1–30 Sep	FS[g]	1–25 Sep	FS[e]		

[a] Since 1987 the taking of white-phased or partial albino (more than 50%) white moose has been prohibited.
[b] R = residents, N = nonresidents, and S = subsistence.
[c] Bag limit bulls with ≥50-inch antler spread.
[d] Only that portion of Unit 20F drained by the Yukon River downstream from the mouth of Hess Creek.
[e] Federal subsistence season for residents of Minto, Manley, and Stevens Village to hunt moose in Unit 20F on federal public lands.
[f] Only that portion of Unit 20F drained by the Yukon River excluding the Tanana River drainage downstream from the drainage of Hess Creek.
[g] Federal subsistence season for residents of Cantwell, Lake Minchumina, Telida, and Nikolai to hunt moose in Unit 20C on federal public lands within Denali National Park and Preserve.

Table 3 Units 20C, 20F, and 25C reported moose hunter residency and success, regulatory years 1990–1991 through 2001–2002

Regulatory year	Successful hunters					Unsuccessful hunters					Total hunters
	Resident	Nonresident	Unk	Total	(%)	Resident	Nonresident	Unk	Total	(%)	
Unit 20C											
1990–1991	108	4	4	116	(38)	178	6	5	189	(62)	305
1991–1992	131	9	2	142	(37)	229	2	3	234	(63)	376
1992–1993	56	5	5	66	(21)	228	9	8	245	(79)	311
1993–1994	118	9	3	130	(33)	247	9	3	259	(67)	389
1994–1995	131	9	12	152	(36)	241	9	17	267	(64)	419
1995–1996	108	9	4	121	(32)	254	7	0	261	(68)	382
1996–1997	114	9	0	123	(35)	221	11	0	232	(65)	355
1997–1998	125	17	1	143	(37)	224	12	3	239	(63)	382
1998–1999	125	14	1	140	(35)	242	13	1	256	(65)	396
1999–2000	118	13	0	131	(32)	262	17	3	282	(68)	413
2000–2001	117	13	0	130	(28)	301	25	1	327	(72)	457
2001–2002[a]	107	14	0	121	(38)	159	13	22	194	(62)	315
Unit 20F											
1990–1991[b]	38	0	0	38	(31)	84	0	2	86	(69)	124
1991–1992	36	1	0	37	(24)	109	3	6	118	(76)	155
1992–1993	25	0	2	27	(20)	104	1	2	107	(80)	134
1993–1994	22	0	2	24	(26)	65	1	1	67	(74)	91
1994–1995	29	2	0	31	(23)	100	3	3	106	(77)	137
1995–1996	39	0	0	39	(32)	83	0	0	83	(68)	122
1996–1997	30	0	0	30	(23)	99	1	0	100	(77)	130
1997–1998	28	1	0	29	(25)	89	0	0	89	(75)	118
1998–1999	44	1	0	45	(29)	106	3	0	109	(71)	154
1999–2000	31	1	1	33	(25)	96	2	0	98	(75)	131
2000–2001	36	4	0	40	(24)	125	1	0	126	(76)	166
2001–2002[a]	24	0	1	25	(31)	51	1	4	56	(69)	81
Unit 25C											
1990–1991	38	4	1	43	(23)	129	7	7	143	(77)	186
1991–1992	43	3	0	46	(28)	108	7	3	118	(72)	164
1992–1993	32	7	0	39	(19)	161	5	1	167	(81)	206
1993–1994	47	7	1	55	(25)	157	7	0	164	(75)	219
1994–1995	45	9	1	55	(24)	158	12	1	171	(76)	226
1995–1996	51	5	0	56	(28)	130	11	0	141	(72)	197
1996–1997	47	11	0	58	(27)	138	18	0	156	(73)	214
1997–1998	47	10	0	57	(27)	140	13	2	155	(73)	212
1998–1999	73	11	1	85	(34)	152	13	2	167	(66)	252
1999–2000	55	14	1	70	(26)	177	19	6	202	(74)	272
2000–2001	59	19	1	79	(24)	224	20	0	244	(76)	323
2001–2002[a]	41	8	8	57	(25)	146	15	14	175	((75)	232

[a] Preliminary results.
[b] Excludes hunters in permit hunts.

Table 4 Residency of successful moose hunters in Units 20C and 20F, 2000–2001

Unit	Town	Successful hunters
20C	Nonlocal	
	Fairbanks, North Pole, Salcha, Two Rivers	51
	Wasilla, Palmer, Eagle River, Anchorage, Big Lake, Chugiak, Elmendorf AFB	25
	Other residents	6
	Nonresidents	13
	Subtotal	95
	Local	
	Denali Park	1
	Nenana	4
	Tanana	2
	Manley Hot Springs	0
	Healy/Clear/Anderson	21
	Lake Minchumina	7
	Kantishna	0
	Subtotal	35
20F	Nonlocal	
	Fairbanks, North Pole, Eielson AFB, Fort Wainwright, Delta Junction	18
	Anchorage, Eagle River, Chugiak, Big Lake, Wasilla, Palmer	7
	Other residents	2
	Nonresidents	4
	Subtotal	31
	Local	
	Tanana	6
	Rampart	2
	Manley Hot Springs	1
	Subtotal	9
25C	Nonlocal	
	Fairbanks, North Pole, Fort Wainwright, Eielson AFB, Two Rivers	32
	Anchorage, Wasilla, Palmer, Chugiak	17
	Other residents	4
	Nonresidents	19
	Subtotal	72
	Local	
	Central	5
	Circle	1
	Subtotal	6

Table 5 Units 20C, 20F, and 25C reported moose harvest chronology by month/day, regulatory years 1992–1993 through 2001–2002

Regulatory year	Harvest chronology by month/day						Total
	9/1–9/7	9/8–9/15	9/16–9/20	9/21–9/30	12/1–12/10	Unknown	
Unit 20C							
1992–1993	28	15	19				62
1993–1994	40	53	32	3			128
1994–1995	32	70	40	1			143
1995–1996	33	49	35	3			120
1996–1997	37	52	31	4			124
1997–1998	38	54	39	1			132
1998–1999	35	54	42	3			134
1999–2000	35	52	39				126
2000–2001	41	48	36				125
2001–2002[a]	26	52	44				122
Unit 20F							
1992–1993	9	10	2	1	4		26
1993–1994	8	12	1		3		24
1994–1995	15	15			1		31
1995–1996	7	19	14		1		41
1996–1997	6	23	6		0		35
1997–1998	4	13	10	1	0		28
1998–1999	11	25	6		3		45
1999–2000	5	18	4		5		32
2000–2001	10	21	5		4		40
2001–2002[a]	5	12	9		0		26
Unit 25C							
1992–1993	20	19					39
1993–1994	23	25	6	1			55
1994–1995	27	23	1	1			52
1995–1996	23	29	3				55
1996–1997	20	34	1	1		2	58
1997–1998	22	34	0	1			57
1998–1999	35	47	2				84
1999–2000	31	37					68
2000–2001	28	50					78
2001–2002[a]	21	33					54

[a] Preliminary results.

Table 6 Units 20C, 20F, and 25C reported moose harvest percent by transport method, regulatory years 1990–1991 through 2001–2002

	Harvest percent by transport method								
Regulatory year	Airplane	Horse/Dogsled	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unk/other	*n*
Unit 20C									
1990–1991	24	0	41	11	0	11	9	3	116
1991–1992	23	0	39	20	0	7	8	3	142
1992–1993	32	0	32	12	6	8	10	0	66
1993–1994	22	2	44	15	1	13	3	0	130
1994–1995	26	1	37	21	0	7	5	1	152
1995–1996	29	0	37	14	0	12	7	0	121
1996–1997	28	0	26	21	0	11	8	6	127
1997–1998	21	0	38	21	0	13	6	2	143
1998–1999	16	1	33	24	0	19	5	2	140
1999–2000	15	2	38	20	0	18	5	2	131
2000–2001	22	0	36	23	1	12	5	1	130
2001–2002[a]	23	2	31	21	0	13	11	0	131
Unit 20F									
1990–1991	11	0	63	16	0	0	11	0	38
1991–1992	8	3	57	11	3	3	14	3	37
1992–1993	7	4	44	7	15	0	19	4	27
1993–1994	4	4	38	13	8	4	29	0	24
1994–1995	3	0	39	23	0	13	22	0	31
1995–1996	3	0	54	20	0	3	22	0	41
1996–1997	3	3	57	14	6	0	17	0	35
1997–1998	3	0	45	31	0	3	17	0	29
1998–1999	0	2	56	16	4	2	20	0	45
1999–2000	3	0	33	27	12	6	15	3	33
2000–2001	5	0	45	30	8	0	10	2	40
2001–2002[a]	0	0	48	24	0	8	16	4	25
Unit 25C									
1990–1991	2	0	9	35	0	14	37	2	43
1991–1992	11	0	22	44	0	0	20	4	46
1992–1993	18	0	13	33	0	8	26	3	39
1993–1994	9	0	36	24	0	5	24	2	55
1994–1995	13	0	24	38	0	9	15	1	55
1995–1996	9	0	29	25	0	9	27	2	56
1996–1997	9	0	22	36	0	5	28	0	58

	Harvest percent by transport method								
Regulatory year	Airplane	Horse/Dogsled	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unk/other	*n*
1997–1998	7	0	18	53	0	7	14	2	57
1998–1999	4	0	21	40	0	5	28	2	85
1999–2000	9	0	26	39	0	3	24	0	70
2000–2001	5	0	24	38	0	6	25	1	19
2001–2002[a]	7	0	26	53	0	7	5	2	57

[a] Preliminary results.

Table 7 Estimate of Units 20C, 20F, and 25C moose harvest and accidental death, regulatory years 1997–1998 through 2001–2002

Regulatory year	Harvest by hunters							Accidental death			Total
	Reported[a]				Estimated						
	M	F	Unk	Total	Unreported[b]	Illegal/Other[c]	Total	Road[d]	Train[e]	Total	
Unit 20C											
1997–1998	143	0	0	143	25	0	25	1	8	9	177
1998–1999	140	0	0	140	25	1	26	0	3	3	169
1999–2000	125	0	0	125	22	0	22	0	21	21	168
2000–2001	130	0	0	130	23	0	23	0	0	0	153
2001–2002[f]	131	0	0	131	23	0	23	0	0	0	154
Unit 20F											
1997–1998	29	0	0	29	5	1	6	1	0	1	36
1998–1999	45	0	0	45	8	1	9	0	0	0	54
1999–2000	33	0	0	33	6	2	8	1	0	1	42
2000–2001	40	0	0	40	7	0	7	0	0	0	47
2001–2002[f]	25	0	0	25	4	0	4	0	0	0	29
Unit 25C											
1997–1998	57	0	0	57	10	0	10	0	0	0	67
1998–1999	85	0	0	85	15	0	15	3	0	3	103
1999–2000	66	0	0	66	11	0	11	0	0	0	77
2000–2001	79	0	0	79	14	1	15	0	0	0	94
2001–2002[f]	57	0	0	57	10	0	10	0	0	0	67

[a] Data from ADF&G harvest reports.
[b] Based on 17.7% unreported harvest (including wounding loss) estimated by Gasaway et al. (1992).
[c] Data from Fairbanks Fish and Wildlife Protection wildlife mortality logs.
[d] Documented kills from Fairbanks Fish and Wildlife Protection wildlife mortality logs.
[e] Confirmed dead between Alaska Railroad mileposts 327.0–370.9; "missing" (moose hit but not recovered) are not included. Data provided by the Alaska Railroad and summarized by ADF&G office in Palmer. Data were not available for May and June 2000.
[f] Preliminary data.

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MOOSE MANAGEMENT REPORT

From: 1 July 1999
To: 30 June 2001

LOCATION

GAME MANAGEMENT UNIT: 20D (5637 mi^2)

GEOGRAPHIC DESCRIPTION: Central Tanana Valley near Delta Junction

BACKGROUND

Unit 20D was created in 1971 from a portion of Unit 20C. During 1962–1970, the moose hunting season in the area that is currently Unit 20D consisted of a 70–72 day bull season and a 1–8 day antlerless moose season. Most (51–74%) of the harvest during 1964–1970 came from the highly accessible areas near Delta Junction (Clearwater Lake, Donnelly Dome, and the Delta farming area). However, several severe winters in the mid 1960s and early 1970s killed many moose throughout this subunit and other portions of Interior Alaska and set the stage for predation and hunting to compound and aggravate already widespread population declines. Poor recruitment of yearlings to the population in combination with intense bulls–only hunting depressed the bull:cow ratio to only 4:100 in the more accessible portions of the subunit. The moose hunting season was closed during 1971–1973 because the depressed moose population could no longer support any significant harvest (McIlroy 1974).

Despite restrictions on hunting, the moose population in Unit 20D continued to decline because of chronically high moose mortality from other causes. In 1973 the moose population in the area south of the Tanana River and between the Johnson and Delta Rivers was estimated at only 600. When limited moose hunting was resumed in 1974, it was conducted under a registration permit system for the entire unit, however, an area around Delta Junction was closed to the taking of antlerless moose. The moose population decline in the western portion of the subunit was gradually reversed by a combination of continued hunting restrictions, mild winters, and wolf control efforts in adjacent Unit 20A (1976–1982) and western Unit 20D (1980–1983).

In 1978 the subunit was enlarged by moving the eastern boundary from the Johnson River to the Robertson River. It was further enlarged in 1981 to include all drainages north of the Tanana River from the mouth of the Robertson River to Banner Creek.

In 1983 the closed area around Delta Junction, which had been established in 1974, was formally named the Delta Junction Management Area (DJMA). The name of the DJMA was changed to

the Delta Junction Closed Area (DJCA) in 1990 to more accurately reflect its status as an area closed to hunting. In 1991 the DJCA was reduced in size to provide more hunting opportunity in the area. In 1996 the DJCA was renamed the DJMA and a drawing permit hunt was established in the area.

Unit 20D has been subdivided into 4 areas for moose management purposes: southwestern Unit 20D, the area south of the Tanana River from the Johnson River to the Delta River; southeastern Unit 20D, the area south of the Tanana River from the Robertson River to the Johnson River; northwestern Unit 20D, the area north of the Tanana River from Banner Creek to and including the Volkmar River; and northeastern Unit 20D, the area north of the Tanana River and east of the Volkmar River.

As moose populations recovered during the mid–1970s and early 1980s, hunting opportunities were expanded in southwestern Unit 20D by first eliminating the registration permit requirement and then by lengthening the season. Antler restrictions were implemented in 1988 to stabilize the increasing harvest and to improve the age structure in the bull segment of the population. In southeastern and northern Unit 20D, the seasons were also increased.

In March 1995 the Alaska Board of Game determined that the preferred use of moose in Unit 20D was for human consumption and they established a moose population objective of 8000–10,000 and an annual harvest objective of 240–500. The harvest objective was increased to 500–700 moose in 2000.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVE

- Increase the fall moose population to 8000–10,000 moose with an annual reported sustainable harvest of 500–700 moose per year.

METHODS

The primary method of collecting moose population data in Unit 20D during the approximate period 1980–1994 was aerial surveys of Trend Count Areas (TCA). Trend count areas were usually surveyed annually or biennially to collect sex and age composition data and population trend. Moose composition and population trends within the TCA were then extrapolated to a larger area. Trend count areas were 40–100 mi^2 and were subdivided into sample units (SU) of approximately 12 mi^2. Although TCAs were searched in their entirety, SUs within TCAs were surveyed individually with standardized search effort and survey conditions so survey variables were constant and their influence was minimized. One disadvantage of TCA surveys was inaccuracy extrapolating moose population estimates outside of TCA boundaries.

Aerial survey techniques were developed in the mid–1980s that allowed precise estimates of moose population size and unbiased composition data to be collected over large areas using stratified random sampling (Gasaway et al. 1986). This technique, known as the Gasaway method, was expensive and labor intensive; therefore, Gasaway population estimates were conducted only occasionally in the highest priority areas.

When the Alaska Board of Game established Unit 20D moose management goals, it became important to have a moose population estimate that could be monitored for compliance. There are also other advantages to calculating population estimates for an area. Gasaway and DuBois (1987) stated that "the primary moose population parameters required to make timely and effective management decisions are abundance, sex and age composition (including recruitment), rate of change in abundance, and mortality rates." Unlike TCA data, population estimates provide 3 of the 4 population parameters recommended by Gasaway and DuBois. However, funding had never been provided to conduct a Gasaway population estimate for all of Unit 20D. Therefore, in fall 1995 I decided to divide Unit 20D into 3 portions and use annual TCA survey funds to conduct Gasaway population estimates in each portion on a rotational basis. Once I had calculated population estimates for each portion of the unit, I could combine the individual estimates to calculate a total unit estimate.

I conducted the first Gasaway-method population estimate in fall 1995 in Unit 20D south of the Tanana River and estimated 2522 moose. Again using the Gasaway method, in fall 1996 I conducted an estimate in northwestern Unit 20D and estimated 1143 moose and in fall 1997 I conducted an estimate in northeastern Unit 20D and estimated 883 moose. The combined 1995–1997 Unit 20D population estimate was 4548 moose (range = 3847–5249).

In the mid–1990s, Ver Hoef (2001) worked to modify the Gasaway method to compensate for its disadvantages. He developed the Geostatistical Population Estimator (GSPE) based on the Gasaway method, but modified it to incorporate spatial statistics and autocorrelation. In previous reports, the GSPE method was called the spatial statistics method (SSM). Geostatistical population estimator advantages over the Gasaway method include: 1) autocorrelation produces a more accurate population estimate; 2) stratification is not required to be as accurate or time sensitive; 3) the GSPE can be conducted for lower cost and manpower; 4) the GSPE can be conducted over a longer survey period, making interruptions due to poor weather less problematic; 5) complete random sampling is not necessary and old survey areas can be incorporated in the GSPE; 6) more accurate estimates of population abundance, composition, and trend are achievable because GSPEs can be conducted more frequently; and 7) application of data from 1 survey area to adjacent survey areas is possible. Based on the advantages of the GSPE, I decided to replace Gasaway population estimates with the GSPE in 1998.

Guidelines recommended by Ver Hoef (personal communication) to maximize accuracy and precision of GSPE surveys were to 1) sample at least 25 SUs in each stratum and 2) sample a smaller number of units annually, rather than a larger number biennially. Therefore, based on Unit 20D funding levels, he recommended that I alternate primary and secondary survey areas with the goal of sampling 40 SUs in the primary area and 10 SUs in the secondary area each year. This would allow data to be collected from each area annually, thus allowing more precise calculation of population trends in the future. Of the 40 SUs in the primary survey area, 60% would be sampled in the high-density stratum and 40% in the low-density stratum. Of the 10 SUs in the secondary area, 80% would be sampled in the high-density stratum and 20% in the low stratum. This sample design did not provide for 25 SUs in each stratum but was the best design possible with available funds.

One significant difference between the Gasaway method and the GSPE surveys is that GSPE surveys do not employ a sightability correction factor (SCF) at this time, and thus it does not correct for moose not seen during the survey. The Gasaway method attempted to maintain consistently high sightability of moose during surveys by flying SUs at a standard search intensity of 4–6 min/mi^2 (Gasaway et al. 1986). A SCF was then calculated independently of the sampling effort by resurveying a portion of each SU at an intensive search effort of 12 min/mi^2. The SCF was based on the number of moose not seen during the standard search but seen on the intensive search. During the GSPE survey, the standard search effort was increased to 8–10 min/mi^2 to achieve an initial higher level of sightability during the survey than the Gasaway method standard search of 4–6 min/mi^2. Ver Hoef and others plan to research the assumption that 8–10 min/mi^2 of search effort is adequate to negate the need for a SCF (Ver Hoef, personal communication).

Geostatistical Population Estimator SUs are square in shape and drawn with boundaries every 2 degrees of latitude on even latitude increments and every 5 degrees of longitude on multiples of 5 degrees. Sample units vary in size from approximately 5.7–5.9 mi^2. Each SU is identified by the latitude and longitude of its southeast corner.

Sample units were stratified as high or low density of moose based on previous stratifications and existing knowledge of the area. In general, SUs were stratified low if I expected to count <5 moose in them. Sample units were stratified high if I expected to count ≥5 moose in them. In an attempt to keep variance as small as possible in the low stratum estimate, I placed borderline SUs in the high stratum.

Sample units were surveyed with a Piper PA–18 Super Cub and a Robinson R-22 helicopter. Aerial surveys were flown at altitudes of approximately 300–800 ft above ground level, depending on vegetative cover. Flight speed was 60–70 mph in the PA–18 and 50–60 mph in the R-22. When terrain permitted, east–west linear transects were flown every 0.15 degrees of latitude, or north–south every 0.3 degrees of longitude. A global positioning system (GPS) was used to follow transect headings. In hilly or mountainous terrain, the flight path followed terrain contours within SU boundaries, rather than transects. Our goal was to spend 8–10 min/mi^2 of search effort in SUs to achieve consistently high sightability of moose. However, large areas of nonmoose habitat (i.e., lakes, areas covered with ice) within a SU were not surveyed.

We circled all moose seen to look for additional moose and to classify moose as bulls, cows, or calves. Bulls were further classified into 5 categories based on antler size and morphology that included: 1) yearlings with spike–fork antlers, 2) yearlings with nonspike–fork antlers, 3) medium bulls with antler spread of 31–40 inches, 4) medium bulls with antler spread 41–49 inches, and 5) large bulls with antler spread ≥50 inches. We estimated antler spread on all medium and large bulls. We identified yearling bulls as those with antler spread <30 inches and with no antler brow palm development.

Information recorded for each SU included: 1) survey start and stop times, 2) snow and light conditions, 3) major habitat type, 4) location, and 5) survey rating of excellent to poor based on the observer's general impression.

Sample unit data were entered into a Microsoft®Excel spreadsheet and analyzed with S-PLUS 2000 software (Mathsoft, Seattle, WA, spatial statistics model) using a spatial statistics model developed by Ver Hoef.

1999 POPULATION SURVEYS

Northern Unit 20D. I established northern Unit 20D as the primary GSPE survey area and southern Unit 20D as the secondary area. Northern Unit 20D included all of Unit 20D north of the Tanana River.

Based on funding availability, the goal of the 1999 survey was to sample approximately 40 SUs in the primary survey area of northern Unit 20D. A random selection of SUs was drawn with 40% of planned effort in the low stratum and 60% of effort in the high stratum. Also, a small secondary survey was conducted in southern Unit 20D. Ten SUs were randomly selected and surveyed in southern Unit 20D, with 20% in the low stratum and 80% in the high stratum.

Shaw Creek Flats and Central Creek Survey. Teck Resources Inc. provided funds and requested that the department conduct aerial moose surveys in the Shaw Creek drainage and in the area previously surveyed as the Central Creek TCA. The purpose of the surveys was to collect moose distribution and population data comparable to standard department surveys, to be used by Teck Resources Inc. to evaluate transportation options to the Pogo Mine Project in the Goodpaster River drainage.

Survey objectives were to 1) estimate moose distribution within the Shaw Creek drainage, 2) calculate a population estimate for the Shaw Creek drainage with precision ≥ 90% confidence interval and with a width less than ±25%, with no precision goals for sex and age composition, and 3) count observable moose within the Central Creek TCA for comparison to earlier surveys.

Moose distribution within the Shaw Creek drainage was determined by stratifying the area based on GSPE SUs established during northern Unit 20D population estimates. We stratified SUs by flying east–west transects through the midpoint of each SU. Sample units were stratified as either high or low moose density relative to the study area, based on aerial observations of habitat, tracks, moose seen during the stratification flight and current knowledge about the area. The flight was made in a Robinson R-22 helicopter at an altitude of approximately 800 ft above ground level and an airspeed of approximately 50–60 mph.

After the stratification, we randomly selected SUs from each stratum with the goal of placing 60% of the sampling effort into the high-density stratum and 40% into the low stratum. Additional SUs were also counted within the study area during the department's northern Unit 20D population survey.

All survey and data analysis techniques were the same as described above for the 1999 northern Unit 20D population estimate.

The Central Creek TCA was flown in a Piper Super Cub PA–18, with the goal of applying 4–6 min/mi^2 of search effort in each SU to be consistent with previous TCA surveys in this area.

Surveys were flown at an airspeed of 70–80 mph at an altitude of approximately 500–700 ft above ground level. We plotted all moose seen on 1:63,360 scale USGS topographic maps.

Data analysis consisted of comparing the number of moose seen during this survey to data from 1992 through 1994.

2000 POPULATION SURVEYS

A GSPE survey was conducted in southern Unit 20D. All survey techniques were the same as for 1999 except the sampling design.

The optimum GSPE spatial sampling design is adjacent pairs of SUs distributed evenly, rather than randomly, throughout the survey area (Ver Hoef, ADF&G, personal communication). The paired SUs allow for optimum spatial comparisons and calculation of autocorrelation. However, in past GSPE surveys, Ver Hoef recommended random sampling of SUs because it 1) generally achieves an adequate spatial sampling pattern, 2) eliminates bias in SU selection, and 3) allows calculation of a population estimate based on the Gasaway-method randomized sampling design, if desired. However, it is possible to draw a random selection of SUs that is far from optimum for spatial sampling. This occurs if there are large unsampled blocks within the survey area and if there are few adjacent SUs.

For the 2000 population estimate in southern Unit 20D, I identified 4 high-density areas of special interest. These included the Hajdukovich Creek burn, the Granite Creek burn, the Delta Agricultural Project, and the subalpine zone of the Macomb Plateau. I identified those SUs that encompassed these areas and randomly selected 1 SU from each area. I then randomly selected an adjacent SU to form a pair of SUs within the area of interest. Repeating this process for each area of interest resulted in 8 SUs being assigned of the 24 available to be sampled in the high-density stratum. I then randomly assigned the remaining 16 high density SUs throughout the remainder of the survey area. I did not identify any areas of special interest within the low-density stratum, and 14 of 16 low density SUs were assigned randomly, but I placed 2 SUs randomly in large areas that were unsampled in the original allocation.

Individual GSPE population estimates were calculated for southwest and southeast Unit 20D because moose hunting regulations differ in southern Unit 20D east and west of the Johnson River.

Moose Twinning Surveys. Moose twinning surveys were conducted for the first time in Unit 20D. Southwestern Unit 20D was chosen for the survey because it had the highest density of moose. Southwestern Unit 20D does not have a core moose calving area, so survey areas were drawn on 1:63,360 scale USGS topographic maps to be representative of habitat throughout the area. Survey areas with their approximate size in square miles were established as follows: Jarvis Creek West (7.4), Butch Lake (9.5), Granite/Rhodes Creek (9.0), Big Lake (20.8), Clearwater Creek (13.0), Sawmill Creek North (16.2), Sawmill Creek South (12.4), and the Delta Agricultural Project (156). In addition, an exploratory survey was conducted without specific boundaries in the Tanana Loop area north of Delta Junction.

Survey transects were flown approximately 0.5 mi apart in a Piper Super Cub PA–18, at an altitude of 300–700 ft above ground level and an airspeed of 70–80 mph. Large areas with little chance of having a moose (i.e., large agricultural grain fields) or little chance of spotting a moose (i.e., dense stands of spruce) were not surveyed. When moose were spotted, a pass was made over the moose to look for a calf and to look for antler growth to determine if the moose was a bull. If the moose was a cow, a low pass was made over the cow to stimulate calves to stand up. Typically, about 1–2 additional passes were made over the cow to look for a calf and to determine if the cow had a single calf or twins.

Moose Browse Surveys. Moose browse surveys were conducted in southwestern Unit 20D during April and early May to assess relative browsing pressure. The technique used was developed by C.T. Seaton as part of his thesis at the University of Alaska Fairbanks to evaluate browse over large areas such as game management units.

The 1987 Granite Creek fire and Donnelly Dome areas in southwestern Unit 20D were selected to be surveyed because of the high density of moose in these areas. Trails and roads were identified through the areas that could be accessed by snowmachine or 4–wheeler. Survey plots were established by systematically preselecting stopping points along trails and roads (i.e., every mile along a trail). At each stop, a random compass heading and number of paces from the trail, not to exceed 100 paces, was selected as the center point of the plot. A GPS was used to identify the latitude and longitude for the center. The plot consisted of a circle having a radius of 15 m from the center point. The approximate boundaries of the plot were identified by pacing 15 m from the center in 4 cardinal directions and tying flagging tape to a plant at that point.

Once the plot was identified, preferred browse species within the plot were identified. Preferred species were considered to be *Salix* spp., *Betula paperifera*, and *Populus* spp. that were >0.5 m in height but not taller than 3 m. The number of each preferred species within the plot was estimated and recorded. Nonpreferred species and their number were also recorded within the plot. Nonpreferred species consisted of spruce (*Picea* spp.), tamarack (*Larix laricina*), alder (*Alnus* spp.), and resin birch (*Betual grandulosa*).

Browse use was assessed by sampling current annual growth (CAG) leaders from at least 3 different plants for each preferred species if possible. The 3 plants for each preferred browse species to be sampled were randomly selected from within the plot. The following information was recorded for each plant: height from the ground, number of CAG leaders present before browsing, proportion of dead plant material, and plant architecture (broomed, browsed, or unbrowsed). Next, 10 CAG leaders were selected from each plant and the following information was recorded for each stem: stem diameter at the base of the CAG, was the stem browsed or unbrowsed, and the diameter of the stem at the point of browsing. Finally, nonpreferred browse species were observed for evidence of browsing.

2001 POPULATION SURVEYS

Southern Unit 20D was again selected as the primary survey area because of the intensive moose management and regulatory concerns in this area. A GPSE population survey was conducted using the same survey methodology described for 2000, except for SU selection. SUs were

selected to optimize GSPE spatial sampling design by selecting adjacent pairs of SUs distributed evenly, rather than randomly, throughout the survey area.

The number of SUs to be surveyed in each stratum was divided by 2 to determine the number of SUs pairs that would be sampled. Then the total number of SUs in each stratum was divided by the number of pairs to be sampled, to determine how many SUs would be grouped together to be represented by 1 sampled pair. I grouped SUs with similar anticipated moose densities, habitat types, and topographic features.

For example, in 2001 funding was available to survey 24 SUs in the high-density stratum, which consisted of 119 SUs. The 24 SUs to be surveyed in the high stratum equaled 12 paired SUs. Therefore, a pair of SUs were allocated for approximately every 10 high density SUs. I then used a map of SUs to identify SU groups, averaging 10 SUs (range 8–12). The following SU groups were established with the number of SUs in each: Robertson River (9), Berry Creek (10), Knob Ridge (10), Johnson–Gerstle (11), Upper Sawmill Creek (8), Cummings Road (11), Jarvis Creek (11), Delta River (10), 12–mile Crossing (10), 33–mile Loop Road (9), 1408 Road (8), and Clearwater Lake (12). Once groups were identified, an adjacent pair of SUs was selected from within each group to be sampled.

This process was repeated for the low density stratum, which had 7 SU groups, ranging from 23–27 SUs each. The following low density groups and their number of SUs were established as follows: Robertson River (23), Dot Lake (26), Independent Ridge (27), Gerstle River (25), Jarvis Creek (25), Delta Agricultural Project (25), and Delta Junction (25).

Additional moose survey funds became available after completion of the 2001 GSPE survey, and southern Unit 20D was stratified from 24 November–12 December using a Piper PA–18 Super Cub. The stratification was conducted using GSPE SUs. We stratified by flying east–west transects through the midpoint of each SU. The proportion of habitat in each SU was estimated and classified as low shrub (generally *Salix* spp.), tall shrub, deciduous forest, sparse spruce forest, spruce forest, or nonmoose habitat. The presence of moose tracks and number of moose seen in the SU were recorded. Before exiting the SU, it was stratified as either high or low density.

Moose Twinning Surveys. Moose twinning surveys were conducted in southwest Unit 20D using the same methodology described for 2000. Survey areas with their approximate size in square miles were flown as follows: Jarvis Creek West (7.4), Butch Lake (9.5), Granite/Rhodes Creek (9.0), Big Lake (20.8), Clearwater Creek (13.0), Sawmill Creek North (16.2), and the Delta Agricultural Project (156.0).

Moose Browse Surveys. Moose browse surveys were conducted in southwestern Unit 20D during April and early May to assess relative browsing pressure in the 1994 Hajdukovich Creek burn. The methodology was the same as described for 2000.

Harvest Monitoring. Harvest of moose by hunters during the general hunting seasons was monitored by requiring hunters to acquire moose harvest tickets and report hunting activities that included: the location hunted, how long they hunted, their mode of transportation, whether they killed a moose, where and when they killed a moose, the antler spread and number of brow tines

on moose killed, and the type of weapon used to kill the moose. Hunters participating in permit hunts provided the same information via permit report forms. Harvest data were summarized by regulatory year (RY), which begins 1 July and ends 30 June (e.g., RY99 = 1 Jul 1999–30 Jun 2000). Reminder letters were sent to holders of harvest tickets and permits.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

1999

In fall 1999 we estimated 2395 moose (2070–2719) in northern Unit 20D (Table 1).

After completion of the northern Unit 20D population estimate I combined it with the 1998 population estimate of southern Unit 20D to calculate a Unit 20D population estimate of 6025 moose (4856–7194). An assumption of this calculation is that no significant change occurred in the southern Unit 20D population during this time. This calculation was made by determining the standard error of the sum of the variances for the 2 population estimates. The standard error was then multiplied by the Student *t*-test statistic of 1.68 to obtain the 90% confidence interval ±25% (Gasaway et al. 1986). The confidence interval was then added and subtracted to the population estimate.

Unit 20D has been designated for intensive management by the Board of Game with a population objective of 8000–10,000 moose. The 1998–1999 Unit 20D population estimate is below the population objective.

The Shaw Creek population estimate was conducted during 13–24 November 1999. The population estimate for the drainage was 119 moose (range = 103–136). Confidence intervals were ±14% of the estimate and met the precision goal. Composition in the area was 49 bulls:100 cows (range = 35–63) and the calf:cow ratio was 24:100 (range = 18–30). Moose were distributed throughout the Shaw Creek drainage at relatively low densities.

The Central Creek TCA was flown on 18 November 1999. Search time totaled 2 hr 46 min for a search effort of 4.0 min/mi^2 which met the search intensity goal. We observed 61 moose in the TCA, which was substantially fewer than the 118–139 seen in 1992–1994 when the area was last surveyed by the department.

2000

In fall 2000 I estimated 3932 moose (3245–4618) in southern Unit 20D (Table 2).

Search effort in the SUs that were searched in their entirety (i.e., did not have large areas of nonmoose habitat) averaged 8.0 min/mi^2. This effort meets the minimum goal of 8–10 min/mi^2 of search effort.

Funding did not allow SUs in the northern Unit 20D secondary survey area to be sampled.

Cost to conduct the population estimate was $10,298 for aerial surveys and $122 for miscellaneous expenses, totaling $10,420. On a SU basis, the survey cost $274/SU. On an area

basis, the survey cost $5.51/mi^2. Aircraft charter rates were higher this year than in past years because of increased fuel costs. Poor flying conditions also resulted in more ferry time causing higher cost this year than in previous years.

The 2000 southern Unit 20D population estimate was combined with the 1999 northern Unit 20D population estimate to calculate a new Unit 20D total population estimate of 6327 moose (5551–7103). An assumption in this calculation is that the northern Unit 20D population estimate had not changed significantly since 1999. This population estimate did not meet the Unit 20D moose population goal established by the Board of Game.

2001

In fall 2001 I estimated 3435 moose (2643–4227) in southern Unit 20D (Table 2).

The 2001 southern Unit 20D population estimate was combined with the 1999 northern Unit 20D population estimate to calculate a new Unit 20D total population estimate of 5830 moose (4956–6704). An assumption in this calculation is that the northern Unit 20D population estimate had not changed significantly since 1999. This population estimate did not meet the Unit 20D moose population goal established by the board.

Twinning surveys were flown on 29 and 31 May, and 1, 2, and 4 June 2000 for 12.6 hr of survey time. Most flights began in the evening from 1815 hr to2100 hr and concluded from 2224 hr to 2335 hr. One morning flight was conducted from 0555–0807 hr. Two hundred eighty–two moose were seen at the rate of 22.4 moose/hr of survey time. Forty–seven cow/calf groups were seen, with 7 (15%) being cows with twins.

2002

Twinning surveys were flown on 25, 27, 28, and 29 May 2002 for a total of 11.9 hr of survey time. Flights began in the morning from 0610 hr to 0640 hr and concluded from 0800 hr to 1215 hr. Moose were seen at the rate of 22.5 moose/hr and 268 total moose were seen. Sixty–one cows/calf groups were seen, with 13 (21%) being cows with twins.

Population Composition

1999. The bull:cow ratio in northern Unit 20D was 81:100 (range = 69–93) and the calf:cow ratio was 18:100 (range = 14–22) during fall 1999 (Table 1).

2000. The population composition during fall 2000 in southern Unit 20D was 27 bulls:100 cows (range = 19–34) and 27 calves:100 cows (range = 22–31) (Table 3).

2001. The population composition during fall 2001 in southern Unit 20D was 16 bulls:100 cows (range = 10–22) and 24 calves:100 cows (range = 16–32) (Table 3). This is the lowest bull:cow ratio recorded in southern Unit 20D since population estimates began in the area.

Distribution and Movements

No data were collected on moose distribution or movements during this reporting period.

MORTALITY

Harvest

Season and Bag Limit. Hunting seasons and bag limits were unchanged during RY99–RY01 and are listed in Table 2.

Alaska Board of Game Actions and Emergency Orders. At the March 2000 Alaska Board of Game meeting, the board considered proposal 99 to raise the Unit 20D moose harvest objective from 240–500 moose/year to 500–700 moose/year, with no time frame for accomplishing the objective. The proposal was adopted.

At the March 2002 board meeting there were 5 proposals pertaining to moose regulations in Unit 20D. Proposal 4 was adopted by the board and created the Bison Range Youth Hunt Management Area on a portion of the Delta Junction Bison Range. The purpose of the proposal was to allow the department to better meet bison management objectives by regulating moose hunting. Proposal 5 was adopted to increase the number of drawing permits from 10 to 30 for hunting moose in the DJMA. Proposal 6 was adopted and created a nonresident moose hunting season in the upper Robertson River drainage. This area had previously been closed to nonresident moose hunters because of customary and traditional use considerations in southeastern Unit 20D. Proposal 7 to change the brow tine restriction in southwestern Unit 20D from 4 to 3 brow tines was not adopted. Proposal 12 to create a controlled use area in northern Unit 20D to regulate the use of airboats was not adopted.

Human-Induced Mortality

RY99. Estimated moose mortality from all human causes in Unit 20D during RY99 was 264 moose (Table 4). This included 184 moose reported killed by hunters, an estimated 33 unreported hunter kills, illegal harvest of 7 moose reported by Fish and Wildlife Protection, and 40 road kills reported by Department of Public Safety (DPS). Most illegal kills and road kills occurred in southwestern Unit 20D. Total reported hunting harvest of 184 moose did not meet the harvest objective of 240–500. Reported hunting harvest was 3.1% of the estimated population. Total human-induced mortality was 4.4% of the estimated population.

RY00. Estimated moose mortality from all human causes increased during RY00 to 347 moose (Table 4). This included 246 moose reported killed by hunters during the hunting season, an estimated unreported harvest of 44 moose, 20 moose reported by Fish and Wildlife Protection to have been killed illegally, and 37 road kills reported by DPS. Most illegal kills and road kills occurred in southwestern Unit 20D. Total reported hunting mortality of 246 was slightly below the harvest objective. Reported hunting harvest was 3.9% of the estimated population. Total human-induced mortality was 5.5% of the estimated population.

RY01. Estimated moose mortality from all human causes during RY01 was 263 moose (Table 4). This includes 182 moose reported killed by hunters during the hunting season, an estimated 32 moose harvested but unreported, 17 moose reported by Fish and Wildlife Protection to have been killed illegally, and 32 road kills reported by DPS. Most illegal kills and road kills occurred in southwestern Unit 20D. Total reported hunting mortality of 182 was well below the harvest objective of 500–700. Reported hunting harvest was 3.1% of the estimated population. Total human-induced mortality was 4.5% of the estimated population.

Southwestern Unit 20D Hunter Harvest. Reported hunter harvest in RY99 was 114 moose with 107 taken during the general season and 7 taken during permit hunt DM790 (DJMA) (Tables 5 and 6). During the general season, 358 hunters harvested 107 moose (Table 5), for a 29.9% hunter success rate. Hunters that participated had a 70% success rate during permit hunt DM790 (Table 6).

Reported hunter harvest during RY00 increased to 146 moose, with 140 taken during the general season and 6 taken during permit hunt DM790 (DJMA) (Tables 5 and 6). This is the highest harvest in southwestern Unit 20D since at least 1984. During the general season, 355 hunters killed 140 moose (Table 5) for a 39.4% success rate. Hunters had a 75% success rate during hunt DM790 (Table 6).

Reported hunter harvest during RY01 was 105 moose, with 101 taken during the general season and 4 taken during permit hunt DM790 (DJMA) (Tables 5 and 6). During the general season, 425 hunters killed 101 moose (Table 5) for a 23.8% success rate. This is the second highest number of hunters reported for this area since at least 1984. Hunters that participated had a 50% success rate during hunt DM790.

Southwestern Unit 20D had the most restrictive hunting regulations in the subunit in the form of antler restrictions, yet moose harvest and number of hunters has continued to increase since the regulations were implemented. The increase is likely due to increased numbers of moose and good access in the area.

Southeastern Unit 20D Hunter Harvest. Moose harvest remained low in southeastern Unit 20D. During the general seasons, only 10–12 moose were killed annually during RY99–RY01 (Table 5). Hunter success rates varied from 28% to 32% during this period. No moose were killed in Tier II hunt TM787 (Table 7). Harvest during the general hunting season was low in this area primarily because of motorized access restrictions in the Macomb Plateau Controlled Use Area, which makes moose hunting difficult.

Northwestern Unit 20D Hunter Harvest. During the RY99 general season, 42 moose were killed by 177 hunters (Table 5) for a 23.7% success rate. During the RY00 general season, 65 moose were killed by 194 hunters for a 33.5% success rate. During the RY01 general season, 52 moose were killed by 221 hunters for a 23.5% success rate. There were no permit hunts in northwestern Unit 20D.

Northeastern Unit 20D. Number of hunters and harvest remained low in northeastern Unit 20D during the RY99–RY01 general season. Harvest ranged from only 12 to 18 moose, with hunters ranging from 29 to 41, and success rates ranging from 34 to 51% (Table 5). This area is difficult to access during the hunting season except along the Tanana River, along a few small creeks and rivers flowing into the Tanana River, and at a few ridgetop airstrips.

Moose hunters did not appear to take advantage of the August and January–February moose hunting seasons in the Healy River drainage during RY99–RY01. The Healy River drainage is Uniform Coding Unit (UCU) 501. The number of hunters in UCU 501 ranged from 21 to 24 and reported harvest increased to 5–7/year (Table 8). Harvest in the area increased from a mean of 2.8 (range = 2–5) for the 5 years prior to the increased hunting seasons, to a mean of 6/year

moose harvested in RY99–RY01. However, all moose were reported killed during the 1–15 September general hunting season, and none were reported killed during the August and January–February season.

A problem was discovered in the Wildlife Conservation Information Management database that has created difficulty separating the residency of hunters from Fairbanks versus Healy Lake. However, it appears that during RY99–RY01, Healy Lake residents reported killing 3 moose, local residents of Unit 20D killed 2, Fairbanks residents (which may include some Healy Lake residents) killed 9, nonlocal residents killed 2, and nonresidents killed 2.

In discussions I had with Healy Lake residents, they estimated a community need of 20 moose/yr. Part of the reason for establishing the additional August and January–February seasons in this drainage was to provide an opportunity for them to meet this need during legal hunting seasons.

Hunter Residency. Hunter residency changed significantly from previous reports due to changes in the method of calculating unit residency by Wildlife Conservation Information Management staff (B Lieb, ADF&G, personal communication). The previous method included many nonlocal Unit 20 residents, and particularly Fairbanks residents, as local residents of Unit 20D. This change in data tabulation has been corrected, and Table 9 has been recalculated for all years to reflect the change.

The proportion of local hunters (residing in Unit 20D) has been decreasing since the mid–1980s (Table 9). In 1986–1987, 59% of Unit 20D hunters were local residents. That proportion was fairly stable during the 1990s ranging from 48 to 55%. However, during RY99–RY01, the proportion of local hunters declined to a low of 39% in RY01, due primarily to more nonlocal hunters. An average of 86 nonlocal hunters per year were successful in RY94–RY98, but increased to an average of 116 per year during RY99–RY01 (Table 9).

Hunter Effort. Mean days hunted by all hunters during RY99–RY01 was very similar to the previous 5 years (Table 10).

Permit Hunts. Tier II permit hunt number TM787 was conducted during 1 January–15 February of RY99–RY01. Fifteen permits were issued annually, with a harvest quota of 5 bulls. Participation in the hunt was low with 47% and 60% of permittees not hunting during RY99–RY00. No moose were killed in either year (Table 7). Data were not available for RY01.

Ten permits were issued each year from RY99 through RY01 for hunt DM790. The number of applications increased from 458 in RY98 to 672 in RY99, 784 in RY00, and 697 in RY01. Hunters killed 7 bull moose in RY99, 6 in RY00, and only 4 moose in RY01 (Table 6).

Harvest Chronology. During this reporting period, general season harvest chronology remained similar to previous years, with most harvest occurring during the first 5 days of the 15–day general season (Table 11).

Transport Methods. During this reporting period, highway vehicles, 3- or 4-wheelers, and boats continued to be the most common modes of transportation used by successful hunters (Table 12).

Natural Mortality

No estimates of natural mortality were calculated during this reporting period. However, predation by wolves, grizzly bears, and black bears is believed significant in Unit 20D. Predation is thought to limit moose population growth in the northern half of Unit 20D and account for reduced calf survival in portions of southern Unit 20D.

HABITAT

Assessment

Browse survey data collected in 2000 and 2001 had not been analyzed at the time of this report. Although twinning rates in southwestern Unit 20D indicate browse is limiting production of this high-density moose population, initial impressions from browse surveys is that forage is plentiful.

Enhancement

During RY99-00 we conducted no habitat enhancement projects.

CONCLUSIONS AND RECOMMENDATIONS

Population estimates were completed for Unit 20D and results indicated that the moose population did not meet the objective established by the Board of Game. Unitwide harvest of moose increased but is below the objective established by the board. However, harvest and the number of hunters have been increasing.

The bull:cow ratio in southern Unit 20D was likely declining. The decline was likely due to increasing number of hunters and harvest in southwestern Unit 20D. This situation should be monitored closely in the future and may require further regulatory changes if the ratio gets lower than the present 16 bulls per 100 cows.

Participation in the Tier II permit hunt in southeastern Unit 20D continued to be low and no moose were harvested during RY99–RY00. The necessity for this hunt should be evaluated with consideration given to eliminating the hunt. Extra hunting seasons in the Healy River drainage did not appear to be utilized by residents of Healy Lake, with no moose reported taken during the extra seasons. Therefore, eliminating the August and January–February season in this drainage should be considered.

The unitwide population objective needs to be subdivided, as a minimum, into northern and southern Unit 20D objectives. The unitwide population objective of 8000–10,000 moose does not account for differences in moose density, habitat quality, harvest rates, predation rates, and other factors that are substantially different between these areas.

LITERATURE CITED

GASAWAY WC, SD DUBOIS, DJ REED, AND SJ HARBO. 1986. Estimating moose population parameters from aerial surveys. Biological Paper 22. University of Alaska Fairbanks.

———, AND SD DUBOIS. 1987. Estimating moose population parameters. Proceedings second international moose symposium. *Swedish Wildlife Research*, Supplement 1, Part 2. pp 603–617.

MCILROY C. 1974. Unit 20D moose management progress report of survey-inventory activities. Pages 154–160 *in* D McKnight, editor. Part II. Volume IV. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Grant W-17-5. Job 1. Juneau, Alaska.

VER HOEF JM. 2001. Predicting finite populations from spatially correlated data. 2000 Proceedings of the Section on Statistics and the Environment of the American Statistical Association, pp 93–98.

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Table 1 Results of 1999 Geo–Statistical Population Estimator (GSPE) survey for northern Unit 20D

Parameter	1996–1997 Gasaway method estimate	1999 GSPE
Total $_{pop\ est}$	2026	2395
LCI	1583	2070
UCI	2469	2719
Total $_{calf}$	268	213
LCI	171	165
UCI	365	262
Total $_{cow}$	1255	1181
LCI	967	979
UCI	1543	1384
Total $_{bull}$	504	957
LCI	364	805
UCI	644	1109
Bulls:100 Cows		81
LCI		69
UCI		93
Calves:100 Cows		18
LCI		14
UCI		22

Table 2 Unit 20D moose hunting seasons and bag limits, regulatory years 1999–2000 through 2001–2002

Regulatory year	Area	Season		Bag limit
1999–2000 through 2001–2002	South of Tanana River and west of Johnson River, except Delta Junction Management Area	Resident:	1–15 Sep	1 bull with spike-fork or 50-inch antlers or 4 or more brow tines on at least 1 side.
		Nonresident:	5–15 Sep	1 bull with 50-inch antlers[a].
	Within Delta Junction Management Area	Resident:	1–15 Sep	1 bull with spike-fork or 50-inch antlers or 4 or more brow tines by drawing permits.
		Nonresident:	5–15 Sep	1 bull with 50-inch antlers[a] by drawing permit DM790.
	South of Tanana River and east of Johnson River	Resident:	1–15 Sep	1 bull.
			1 Jan–15 Feb	1 bull by Tier II permit TM787.
		Nonresident:	No open season	
	Within the Healy River drainage	Resident:	15–28 Aug	1 bull with spike-fork antlers.
			1–15 Sep	1 bull.
			1 Jan–15 Feb	1 bull.
		Nonresident:	1–15 Sep	1 bull.
	Remainder of Unit 20D (north of Tanana River)	Resident:	1–15 Sep	1 bull.
		Nonresident:	1–15 Sep	1 bull.

[a] 50-inch antlers defined as having a spread of at least 50 inches or at least 4 brow tines on at least 1 side.

Table 3 Results of population estimates for southern Unit 20D using a "Gasaway" Method survey and Geostatistical Population Estimator (GSPE) surveys, 1995–2001

Parameter	1995 Gasaway method	1998 Gasaway method	1998 GSPE	2000 GSPE	2001 GSPE
Total pop est	2522	4050	3630	3932	3435
LCI	1979	2826	2533	3245	2643
UCI	3065	5275	4727	4618	4227
Total calves	552	937	863	676	575
LCI	411	682	630	498	453
UCI	693	1191	1097	855	697
Total cows	1626	2580	2321	2530	2424
LCI	1271	1741	1570	2021	1840
UCI	1981	3418	3072	3039	3009
Total bulls	343	530	479	671	392
LCI	249	350	305	530	281
UCI	437	710	653	813	504
Bulls:100 Cows	21	21	21	27	16
LCI	17	16	16	19	10
UCI	25	25	25	34	22
Calves:100 Cows	34	36	37	27	24
LCI	29	32	32	22	16
UCI	39	41	42	31	32

Table 4 Unit 20D moose harvest and accidental death, regulatory years 1986–1987 through 2001–2002

Regulatory year	Harvest by hunters							Accidental death			Total
	Reported				Estimated						
	M	F	Unk	Total	Unreported[a]	Illegal	Total	Road	Train[b]	Total	
1986–1987	130	0	0	130	23	4	27	15	0	15	172
1987–1988	126	0	0	126	22	10	32	26	0	26	184
1988–1989	126	0	0	126	22	13	35	27	0	27	188
1989–1990	128	0	0	128	23	9	32	16	0	16	176
1990–1991	118	1	0	119	21	4	25	11	0	11	155
1991–1992	143	1	0	144	25	11	36	13	0	13	193
1992–1993	143	0	1	144	25	5	30	32	0	32	206
1993–1994	154	0	1	155	27	14	41	30	0	30	226
1994–1995	128	0	0	128	23	7	30	31	0	31	189
1995–1996	138	0	0	138	24	20	44	25	0	25	207
1996–1997	214	0	0	214	38	22	60	39	0	39	313
1997–1998	210	0	0	210	37	15	52	48	0	48	310
1998–1999	234	0	0	234	41	11	52	31	0	31	317
1999–2000	184	0	0	184	33	7	40	40	0	40	264
2000–2001	246	0	0	246	44	20	64	37	0	37	347
2001–2002	182	0	0	182	32	17	49	32	0	32	263

[a] Based on 17.7% unreported harvest estimated by Gasaway et al. (1992).
[b] Not applicable in Unit 20D.

Table 5 Southwestern (SW), southeastern (SE), northwestern (NW), and northeastern (NE) Unit 20D reported moose harvest and number of hunters during general seasons, regulatory years 1984–1985 through 2001–2002

Regulatory	Moose harvest						Hunters					
year	SW	SE	NW	NE	Unk	Total	SW	SE	NW	NE	Unk	Total
1984–1985	39[a]	9[b]	40[c]	14[c]	0	102	236[a]	47[b]	294[c]	48[c]	10	635
1985–1986	48[d]	8[b]	60[d]	14[d]	0	130	236[d]	37[b]	272[d]	50[d]	9	604
1986–1987	76[d]	10[b]	40[d]	10[d]	1	137	250[d]	45[b]	232[d]	57[d]	12	596
1987–1988	66[d]	8[b]	43[d]	9[d]	0	126	296[d]	35[b]	208[d]	35[d]	17	591
1988–1989	60[e]	12[b]	39[d]	12[d]	3	126	244[e]	45[b]	201[d]	37[d]	28	555
1989–1990	60[e]	11[b]	41[d]	10[d]	5	127	303[e]	47[b]	191[d]	39[d]	40	620
1990–1991	58[f]	9[c]	40[g]	7[d]	4	118	270[f]	29[c]	195[g]	26[d]	28	548
1991–1992	54[f]	12[c]	66[g]	9[d]	3	144	331[f]	51[c]	231[g]	26[d]	19	658
1992–1993	59[f]	12[c]	58[g]	5[d]	9	143	329[f]	49[c]	257[g]	34[d]	48	717
1993–1994	74[h]	9[c]	58[c]	11[c]	2	154	324	33[c]	259[c]	29[c]	47	692
1994–1995	61[h]	7[c]	49[c]	9[c]	2	128	339	42[c]	267[c]	33[c]	28	709
1995–1996	60[h]	14[c]	50[c]	12[c]	2	138	301	32[c]	237[c]	42[c]	33	645
1996–1997	103[h]	13[c]	74[c]	16[c]	5	211	320	40[c]	267[c]	35[c]	31	693
1997–1998	88[h]	13[c]	72[c]	19[c]	10	202	325[h]	38[c]	241[c]	46[c]	33	683
1998–1999	122[h]	17[c]	64[c]	16[i]	8	227	431[h]	43[c]	231[c]	43[i]	47	795
1999–2000	107[h]	12[c]	42[c]	12[i]	4	177	358[h]	43[c]	177[c]	29[i]	37	644
2000–2001	140[h]	12[c]	65[c]	18[i]	5	240	355[h]	41[c]	194[c]	35[i]	32	657
2001–2002	101[h]	10[c]	52[c]	14[i]	1	178	425[h]	31[c]	221[c]	41[i]	26	744

[a] Season 1–6 Sep; 1 bull.
[b] Season 1–20 Sep; 1 bull.
[c] Season 1–15 Sep; 1 bull.
[d] Season 1–10 Sep; 1 bull.
[e] Season 1–15 Sep; 1 bull with spike-fork or 50-inch antlers or 3 brow tines on 1 antler.
[f] Subsistence/resident season 1–15 Sep; 1 bull with spike-fork or 50-inch antlers or 3 brow tines on 1 antler. Nonresident season 5–15 Sep; 1 bull with 50-inch antlers or 3 brow tines on 1 antler.
[g] West of pipeline season 1–15 Sep; 1 bull. Nonresident season 5–15 Sep; 1 bull with 50-inch antlers or 3 brow tines on 1 side. Remainder area 1–10 Sep; 1 bull.
[h] Resident season 1–15 Sep; 1 bull with spike-fork or 50-inch antlers or 4 brow tines on 1 antler. Nonresident season 5–15 Sep; 1 bull with 50-inch antlers or 4 brow tines on 1 antler.
[i] Resident season within 1–15 Sep; 1 bull. Within Healy River drainage: resident season 15–18 Aug, 1 bull with spike-fork antlers; 1–15 Sep, 1 bull; 1 Jan–15 Feb, 1 bull; nonresident season, 1–15 Sep; 1 bull. Remainder area is resident and nonresident 1–15 Sep, 1 bull.

Table 6 Unit 20D Delta Junction Management Area moose drawing permit harvest, regulatory years 1996–1997 through 2001–2002

Hunt /Area	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Percent bulls	Percent cows	Unk	Harvest
DM790	1996–1997	5	0	40	60	100	0	0	3
DM790	1997–1998	10	20	0	80	100	0	0	8
DM790	1998–1999	10	0	0	100	100	0	0	10
DM790	1999–2000	10	0	30	70	100	0	0	7
DM790	2000–2001	10	20	20	60	100	0	0	6
DM790	2001–2002	10	20	40	40	100	0	0	4

Table 7 Unit 20D moose Tier II permit harvest, regulatory years 1989–1990 through 2001–2002

Hunt number	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Percent bulls	Percent cows	Unk	Harvest
988	1989–1990	15	27	91	9	100	0	0	1
987T	1990–1991	15	20	86	14	100	0	0	1
987T	1991–1992	15	67	100	0	0	0	0	0
987T	1992–1993	15	20	91	9	100	0	0	1
787	1993–1994	15	47	100	0	0	0	0	0
787	1994–1995	15	27	91	9	100	0	0	1
TM787	1995–1996	15	47	100	0	0	0	0	0
TM787	1996–1997	15	53	86	14	100	0	0	1
TM787	1997–1998	15	73	100	0	0	0	0	0
TM787	1998–1999	15	67	100	0	0	0	0	0
TM787	1999–2000	15	47	53	0	0	0	0	0
TM787	2000–2001	15	60	40	0	0	0	0	0
TM787	2001–2002	15	NA	NA	NA	NA	NA	NA	NA

Table 8 Unit 20D Healy River (Uniform Coding Unit 501) reported moose harvest, regulatory years 1993–1994 through 2001–2002

Regulatory year	Unit 20D Healy River	
	Hunters	Harvest
1993–1994[a]	9	2
1994–1995[a]	13	2
1995–1996[a]	24	2
1996–1997[a]	10	2
1997–1998[a]	14	3
1998–1999[b]	19	5
1999–2000[b]	21	7
2000–2001[b]	24	6
2001–2002[b]	23	5

[a] Resident moose hunting season 1–15 Sep, 1 bull.
[b] Resident moose hunting season: 15–28 Aug, 1 spike-fork bull; 1–15 Sep, 1 bull; 1 Jan–15 Feb, 1 bull.

Table 9 Unit 20D moose hunter residency and success[a], regulatory years 1986–1987 through 2001–2002

Regulatory year	Successful						Unsuccessful						Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	(%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	(%)	
1986–1987	83	51	1	2	137	(23)	270	175	12	3	460	(77)	597
1987–1988	64	48	7	6	125	(21)	279	156	18	15	468	(79)	593
1988–1989	71	43	10	2	126	(23)	215	176	31	7	429	(77)	555
1989–1990	53	62	8	4	127	(20)	263	198	23	9	493	(80)	620
1990–1991	64	55	4	3	126	(21)	243	193	31	3	470	(79)	596
1991–1992	72	67	4	1	144	(22)	280	215	13	7	515	(78)	659
1992–1993	65	67	8	3	143	(20)	306	218	37	14	575	(80)	718
1993–1994	82	68	2	2	154	(22)	298	221	17	2	538	(78)	692
1994–1995	59	65	2	2	128	(18)	319	247	11	4	581	(82)	709
1995–1996	66	63	9	4	142	(21)	249	256	20	12	537	(79)	679
1996–1997	91	108	11	1	211	(29)	277	224	14	2	517	(71)	728
1997–1998	102	90	11	0	203	(29)	264	213	26	2	505	(71)	708
1998–1999	105	104	13	4	226	(28)	278	267	24	3	572	(72)	798
1999–2000	70	96	11	0	177	(22)	311	303	24	6	644	(78)	821
2000–2001	86	144	10	0	240	(27)	283	341	29	4	657	(73)	897
2001–2002	54	108	14	2	178	(19)	301	391	47	5	744	(81)	922

[a] Excludes hunters in permit hunts.
[b] Local means reside in Unit 20D.

Table 10 Southwestern, southeastern, northwestern, and northeastern Unit 20D moose hunter success and mean days hunted[a], regulatory years 1986–1987 through 2001–2002

Regulatory	Successful hunters					Unsuccessful hunters				
year	SW	SE	NW	NE	Total	SW	SE	NW	NE	Total
1986–1987	3.8	3.0	5.3	4.1	3.9	5.5	10.5	6.1	7.0	6.0
1987–1988	4.4	7.3	4.8	3.9	4.7	5.3	7.5	6.7	6.5	6.1
1988–1989	4.6	6.2	5.3	4.5	5.0	5.9	6.3	5.8	6.5	6.0
1989–1990	4.7	4.5	4.1	5.1	4.6	9.7	5.7	5.9	5.3	5.9
1990–1991	4.9	6.6	3.9	6.5	4.7	3.5	5.6	5.8	6.3	5.9
1991–1992	6.0	4.9	5.5	4.2	5.6	5.9	7.0	6.8	5.6	6.3
1992–1993	4.7	5.7	5.4	4.9	5.0	5.9	5.1	6.8	5.2	6.2
1993–1994	5.4	4.4	6.2	7.5	5.7	6.2	7.5	6.6	9.4	6.5
1994–1995	5.1	6.3	5.9	4.2	5.4	5.9	4.9	6.2	7.2	6.1
1995–1996	7.2	5.4	5.6	4.5	6.3	6.9	4.9	7.2	7.2	6.9
1996–1997	4.9	4.2	4.9	6.6	5.0	6.5	5.0	6.7	6.9	6.6
1997–1998	5.3	5.3	6.9	5.1	5.9	7.0	5.5	6.7	7.4	6.9
1998–1999	6.9	13.4	7.6	3.8	7.3	8.0	5.3	7.1	9.5	7.7
1999–2000	5.5	8.5	5.7	4.5	5.7	7.7	7.8	7.8	5.4	7.7
2000–2001	5.1	4.6	5.3	4.0	5.0	6.9	7.9	6.9	5.9	6.9
2001–2002	6.4	5.4	6.0	5.5	6.1	6.9	5.8	7.2	5.5	6.9

[a] Excludes permit hunt harvest.

Table 11 Unit 20D moose harvest[a] chronology percent by month/day, regulatory years 1990–1991 through 2001–2002

Regulatory year	Harvest chronology percent by month/day				
	9/1–9/5	9/6–9/10	9/11–9/15	Unk	*n*
1990–1991	57	20	23	0	109
1991–1992	57	22	16	5	141
1992–1993	50	30	18	3	139
1993–1994	42	26	28	4	154
1994–1995	45	25	22	8	128
1995–1996	41	20	33	6	138
1996–1997	51	23	23	3	208
1997–1998	44	24	30	3	196
1998–1999	44	30	24	2	223
1999–2000	41	30	24	5	175
2000–2001	49	27	23	4	237
2001–2002	44	34	21	2	172

[a] Excludes permit hunt harvest.

Table 12 Unit 20D moose harvest percent[a] by transport method, regulatory years 1987–1988 through 2001–2002

Regulatory year	Harvest percent by transport method									*n*
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Airboats	Unknown	
1987–1988	8	2	27	20	0	8	29		6	126
1988–1989	10	2	24	18	0	9	29		9	126
1989–1990	10	3	29	13	0	12	29		3	127
1990–1991	7	0	25	20	0	12	33		3	118
1991–1992	13	3	23	25	0	8	24		3	144
1992–1993	8	1	26	18	<1	8	36		1	143
1993–1994	6	1	30	25	1	7	29		2	154
1994–1995	4	2	29	28	0	11	23		3	128
1995–1996	6	2	33	18	0	8	28		5	142
1996–1997	4	<1	27	28	0	8	31		2	210
1997–1998	5	1	23	32	0	5	31	<1	2	202
1998–1999	7	1	26	26	0	4	34	0	2	227
1999–2000	5	2	21	38	0	5	27	1	2	177
2000–2001	5	1	19	34	0	5	32	2	2	240
2001–2002	3	2	25	34	0	7	24	2	4	178

[a] Excludes permit hunt harvest.

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MOOSE MANAGEMENT REPORT

From: 1 July 1999
To: 30 June 2001

LOCATION

GAME MANAGEMENT UNIT: 20E (10,680 mi^2)

GEOGRAPHIC DESCRIPTION: Charley, Fortymile, and Ladue River drainages

BACKGROUND

During the 1950s to the early 1960s, synchronous to the federal predator control program, the moose population in Unit 20E increased to a minimum of 12,000 moose. The population declined rapidly during 1965 through 1976, reaching an estimated low of 2200 moose. During 1976–2001 the moose population in Unit 20E remained at low densities (0.2–0.6 moose/mi^2). Gasaway et al. (1992) evaluated the roles that predation, nutrition, snow, harvest, and disease played in maintaining the moose population at low densities. They concluded that predation was the primary limiting factor and that other variables had little to no impact.

During the early 1980s, in response to declining moose and caribou populations, the Alaska Department of Fish and Game initiated 2 predator management programs. Between 1981 and 1983 the wolf population was reduced by 54% in a 3800-mi^2 area of Unit 20E using a combination of aerial gunning and public trapping. In addition, grizzly bear hunting regulations were liberalized in 1981, causing moderate harvest increases in portions of the subunit, probable local declines in grizzly bear numbers, and changes in the bear population age and sex structure (Gardner 1999).

Between 1981 and 1990 the moose population increased by about 4–9% per year. The increase was probably due to combined effects of favorable climatic conditions, reduced predation, and an increased number of alternate prey, i.e., Fortymile caribou. During this period the moose population did not increase beyond the ability of wolves and bears to maintain the population at low densities, and between 1990 and 2001 it remained at 0.5–0.6 moose/mi^2.

Prior to 1992, moose in Unit 20E were primarily hunted by local residents as well as residents from Fairbanks and Southeast Alaska. Historically, harvest was low in relation to the moose population and was largely restricted to the Taylor Highway corridor and the Mosquito Fork drainage. During 1992–2000, more hunters from Southcentral Alaska traveled to Unit 20E to hunt moose in response to more restrictive moose hunting regulations in the southcentral units and for the opportunity to hunt both moose and caribou simultaneously.

During the 1960s, high moose densities supported a long hunting season and a bag limit of 1 moose. As moose numbers began to decline, harvests were first reduced by shortening the season length in 1973 and then by eliminating cow seasons in 1974. However, the population continued to decline throughout Unit 20, and in 1977 moose hunting in Unit 20E (then a portion of Unit 20C) was terminated. A 10-day bulls-only season was opened in 1982 and continued until 1991. The season was lengthened to 15 days during 1991–2000. In response to increasing number of hunters and harvest, in most of Unit 20E, the fall moose season was split in 2001 into a 5-day August season and a 10-day September season and was managed under a registration permit.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population in concert with other components of the ecosystem.
- Continue sustained opportunities for subsistence use of moose.
- Maximize sustained opportunities to participate in hunting moose.
- Maximize opportunities for the nonconsumptive use of moose.

MANAGEMENT OBJECTIVES

- Maintain a posthunting ratio of at least 40 bulls:100 cows in all survey areas.

INTENSIVE MANAGEMENT OBJECTIVES

In that portion of Unit 20E within the Fortymile and Ladue River drainages.

- Population: 8000–10,000 moose.
- Harvest: 500–1000 moose annually.

METHODS

POPULATION STATUS

We conducted moose population estimation surveys in southwestern and western Unit 20E (Mosquito Flats and Tok West Study Areas) in 1981, 1988, 1992, 1995 and 1998–2001 and in southeastern and central Unit 20E (Ladue River and Tok Central Study Areas) in 1992, 1996, and 1998–2001. We used the standard Gasaway et al. (1986) technique in 1981 and 1989 and modifications of that technique developed by Mark McNay (ADF&G, personal communication) in 1992 and by Rod Boertje, Jay Ver Hoef, and Craig Gardner (ADF&G) in 1995–1996. During 1998–2001 we used a technique developed by Jay Ver Hoef (2001) that is based on spatial correlation.

The Ladue River Study Area was expanded in 1998 and in 2000 to include more area than was being intensively hunted during the fall and winter moose seasons. To reduce confusion, we renamed this larger area, Tok Central.

During 1999, Yukon Department of Renewable Resources staff used the spatial correlation sampling technique (Ver Hoef 2001) in a 900-mi^2 area adjacent to our Tok Central study area. This allowed us to expand the moose population size and composition estimates to include more of the White and Ladue River drainages in the Yukon.

These data were used to determine population trends and composition in the study areas, to evaluate the effects of wolf and grizzly predation, habitat quality, and harvest, and in combination, to estimate total number of moose in Unit 20E. The different count areas differed in habitat quality, wolf and grizzly bear population densities, and hunter use.

To evaluate the effects on moose of a nonlethal wolf control program (Boertje and Gardner 1999), we surveyed portions of western Unit 20E and northern Unit 20D (referred to Tok West Study Area) using the spatial correlation method (Ver Hoef 2001). This area will be surveyed annually until 2005 to determine moose population and composition trends. The nonlethal wolf control program was conducted in western Unit 20E, northern Unit 20D, and eastern Unit 20B during 1997–2001.

During 1997 and 1999, moose population trend and composition was monitored in northern Unit 20E within the Yukon–Charley Rivers National Preserve by the National Park Service (NPS) (J Burch, NPS, personal communication).

COMPOSITION SURVEYS

Sex and age composition was estimated in 2–10 traditional trend count areas during October and November 1993, 1994, 1996, and 1999, and in 1995, 1996, 1998, and 1999–2001 while conducting population estimation surveys in the Tok West and Tok Central study areas. All moose observed were classified as large bulls (antlers >50 inches), medium bulls (antlers larger than yearlings but <50 inches), yearling bulls (spike, cerviform, or small palmate antlers without brow separation), cows without calves, cows with 1 calf, cows with 2 calves, lone calves, or unidentified moose.

HARVEST

Harvest was estimated using harvest report cards (after reminder letters were sent) and in 2001, within most of Unit 20E, by registration permit reports. Information obtained from the reports was used to determine total harvest, harvest location, hunter residency and success, harvest chronology, and transportation used. Harvest data were summarized by regulatory year (RY), which begins 1 July and ends 30 June (e.g., RY00 = 1 Jul 2000–30 Jun 2001).

HABITAT ENHANCEMENT

Natural wildfires were managed under the Alaska Interagency Fire Management Plan. Three prescribed burns were ignited in Unit 20E during 1997 and 1998 using aerial firing from a Ping-Pong sphere dispenser. Firing activities were conducted following a strict burn prescription

developed specifically for each of the 3 areas and based on the Fire Weather Index and Fire Behavior Prediction modules of the Canadian Forest Fire Danger Rating System (Stocks et al. 1989).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

During 1981–1995, 4 population estimation surveys were conducted in a 964–2978 mi^2 (2500–7700 km^2) area in southwestern Unit 20E (Gardner 1998). The annual rate of increase during 1981–1987 was 1.08, and during 1988–1995 it was 1.01 indicating the moose population in southwestern Unit 20E increased through the 1980s until 1988 and remained relatively stable during 1989–1995.

In 1992 we conducted the first population estimation survey in a 735-mi^2 area in southeastern Unit 20E. The estimated moose population was 652 ± 21% (90% CI). Mean density was 0.89 moose/mi^2, 29% greater than the density found in the adjacent southwestern portion of the subunit. We conducted a population estimate survey in southeastern Unit 20E again in 1996 (944 ± 26%, 90% CI), but results are not directly comparable because during 1992 we did not estimate a sightability correction factor. Based on estimates generated from observed moose, moose numbers in this area increased by 12.9% during 1992–1996, an annual rate of increase of 1.03.

A combination of nonlethal wolf control (fertility control and relocation) and public trapping occurred in western Unit 20E, northeastern Unit 20D, eastern Unit 20B and southeastern Unit 25C during November 1997–April 2001. Wolf numbers were reduced by about 80% within 15 wolf pack territories. Prior to wolf reduction efforts, moose population estimates (0.2–0.5 moose/mi^2) were obtained from portions of this area (Gardner 1998). Brown and black bear harvest records indicate harvest was below sustainable levels in most of the wolf control area. The 1998 through 2001 Tok West (the southern portion of the wolf control area) moose population estimates ranged from 824 ± 19% (90% CI) to 1115 ± 23% (90% CI), 0.43–0.58 moose/mi^2. Regression analysis indicates no change (p = 0.75) in population size since wolves were reduced. Also, the confidence limits of the 4 population estimates overlap indicating no change. Mean densities were 0.43/mi^2.

The 1998 Tok Central (Alaska only) moose population and density estimates were 1444 ± 22% (90% CI) and 0.52 moose/mi^2. Including the Yukon data, the 1999 density estimate within the White and Ladue River drainages and along the Alaska Highway in both Alaska and Yukon was 0.48 moose/mi^2. These data indicate little difference between moose densities across the border and that little change in moose numbers occurred between 1998 and 1999.

The Tok Central area was expanded during both 2000 and 2001 to include areas where more hunting occurs. This increased area offered more high quality moose habitat (previously burned areas) resulting in higher density estimates. The 2000 and 2001 density estimates were 0.70/mi^2 and 0.75/mi^2, respectively.

The NPS conducted population estimation surveys in northern Unit 20E within the Yukon–Charley Rivers National Preserve west of Washington Creek and south of the Yukon River in 1994 and 1997. They found about 0.30 moose/mi^2 during both years (Bruce Dale, ADF&G, personal communication). The NPS surveyed both north and south of the Yukon River in 1999 and the estimate for the entire area was 0.37 moose/mi^2.

No formal surveys were conducted in the northeastern portion of Unit 20E (approximately 15% of the unit). I estimated moose population size (0.3 moose/mi^2) in that area by using a combination of data including the amount of suitable moose habitat, harvest, and the number of moose concentration areas in comparison to the areas in the subunit that were sampled.

Combining the population estimates, the 2001 population estimate for Unit 20E was 4500–5300 moose (0.42–0.53 moose/mi^2 of moose habitat). The 1999 estimate was 4600–5500 moose. The difference between estimates could be due to either sampling (more area was surveyed in 2001, increasing accuracy) or a moose population decline. McNay and DeLong's (1998) PredPrey model incorporating what we know about predator and harvest levels and moose calf and yearling recruitment indicated the population declined by 1–4% annually over the past 4 years.

The Alaska Board of Game identified the moose population within the Fortymile and Ladue River drainages as important for high levels of human consumptive use under the Intensive Management Law (AS 16.05.255[e]–[g]). This designation means the board must consider intensive management if regulatory action to significantly reduce harvest becomes necessary because the population is depleted or has reduced productivity. The board established the population and harvest objectives for Unit 20E moose within the Fortymile and Ladue River drainages at 8000–10,000 and 500–1000 moose. In RY01 neither the population nor harvest objectives were met and, based on moose, caribou, wolf, and grizzly bear population trends, these objectives will not be met in the foreseeable future unless predation is reduced.

Gasaway et al. (1992) reported that the Unit 20E moose population was maintained at a low density dynamic equilibrium (0.2–1.0 moose/mi^2) by wolf and grizzly bear predation and that habitat, harvest, and disease were not limiting population growth. They determined predator management was necessary to increase the moose population and to maintain it at a higher abundance level. There has been much public and scientific debate over whether wolf control combined with public grizzly bear harvest would cause a moose population increase in Unit 20E. Gasaway et al. (1992) recommended altering wolf and bear predation simultaneously. Reducing predation of only 1 species may result in compensatory predation by another species. Opponents of wolf control argue that reducing wolves will not benefit the moose population because grizzly bears are the primary predator on calves, which is the major limiting factor. Additional arguments have been made that wolf control was tried and failed in Unit 20E. They based their conclusions on results of the wolf control program conducted in Unit 20E during 1981–1983. Unfortunately, this program was terminated prematurely due to political decisions.

To simulate potential consequences of different methods of intensive management on moose numbers in the Fortymile/Ladue drainages, I modeled current population status and trend data for moose and their predators using the McNay and DeLong (1998) Predprey model. Results indicate that the Unit 20E moose population continues to be primarily limited by grizzly bear predation on calves. Gasaway et al. (1992) estimated that between 1981 and 1988, 65% of calf

mortality was due to grizzly bears. In order for the model to track current population status, grizzly bears had to cause 58–62% of the calf mortality during 1997–2001.

The effects of wolf predation on Unit 20E moose trend are expected to increase. During 1997–2001, wolf control activities reduced wolf numbers in the western portion of the unit. Wolf numbers will increase substantially in that area once the effects of wolf control end. Throughout the unit, wolf numbers will probably increase because caribou numbers are high and increasing allowing for high wolf productivity and survival. It is highly probable that the Unit 20E moose population will decline to 0.2–0.3 moose/mi^2 unless wolf numbers, grizzly numbers, or both are reduced.

Assuming grizzly bear predation rates remain relatively constant during the next 5 years, the model predicts that the effect of nonlethal wolf control will be minimal on population trend (annual growth rates = 0.97–1.00). Calf:cow ratios will range in the high teens to low-20s:100 cows and the bull:cow ratio will decline due to harvest.

The factors that appear to limit the effects of the nonlethal wolf control program (1997–2001) on moose are high predation rates on calves by grizzly bears, wolf preferences for caribou as their primary prey, and that the program was conducted in only a portion of the subunit. If 80% of the wolves were removed throughout the subunit and bear mortality continued at current rates, the moose population is estimated to increase 3–10% annually. This growth rate is well below levels (λ = 1.15) observed in areas where wolf control was conducted and grizzly bears were not the primary predator on moose (Boertje et al. 1996). It is possible the model is not an accurate predictor in this situation. It may not be able to accurately predict the effects of reducing the current moderate wolf predation rates throughout the year on all moose sex and age classes in relation to continued high grizzly bear predation on calves.

Moose numbers would remain stable or slightly increase (1–3% annually) if the number of grizzly bears or their predation efficiency were reduced by 2–3% annually and wolf predation increased at the expected rate. More significant decrease in grizzly bear numbers (25%) could cause a 5–10% increase. This was the objective for liberalizing the Unit 20E grizzly bear regulations in 1981, i.e., to try to reduce the grizzly bear population through harvest.

Grizzly bear harvest did increase in portions of the unit after bear hunting regulations were liberalized. Sex and age composition data collected from harvested bears indicate that in the area where the greatest harvest occurred, the bear population declined and composition changed to a greater proportion of young males (Gardner 1999). If the intensive management law is implemented in Unit 20E, bear predation rates on calves must be reduced before substantial increases in the moose population can occur. Even with liberalized grizzly bear harvest regulations during 1982–2001, harvest was not high enough to consistently improve moose calf survival, although some improved calf survival was observed.

To reduce the effects of grizzly bear predation on calves, either the number of bears would have to be reduced to a level at which compensatory bear predation is no longer a factor, or the efficiency with which bear kill calves would have to be reduced. Based on personal observations during moose calf mortality studies where grizzly bears were translocated, fewer bears can kill more calves per bear. There must be a point where bear reduction is great enough that fewer

calves will be killed by grizzly bears. Since females with cubs are protected from harvest but are efficient predators on moose calves (Boertje et al. 1988), a greater percentage of males and unaccompanied females would have to occur. Beginning in RY02, grizzly bear regulations will be more liberal by not requiring a trophy tag fee for Alaskan residents. This direction is being attempted again because the number of hunters in the field during the fall is currently over 1,600 and is expected to increase to over 2000 in RY02, the highest since 1972. If through a public awareness campaign the number of grizzly bears incidentally harvested by moose and caribou hunters increases, it may reach a level necessary to cause substantial declines in bear numbers, resulting in increased moose calf and adult survival.

Model results continue to support the recommendation that moderate reductions of wolves and bears would better suit moose management in Unit 20E compared with strong reductions in either predator population (Gasaway et al. 1992). If trappers could remove 30–35% of the wolf population annually and grizzly bear numbers were reduced by 25%, moose numbers could increase 3–12% annually.

If harvest does not prove to be effective in reducing grizzly bear predation on moose, other methods may help reduce bear predation efficiency. Two possibilities for Unit 20E are supplementary feeding of bears (Boertje et al. 1996) or creating a situation where bears are not as efficient a predator. Bear predation efficiency declined in early successional habitats following wildfires (Schwartz and Franzmann 1989). Combining liberal grizzly bear harvests with habitat enhancement programs may increase moose calf survival.

Population Composition

During 2000 and 2001 we collected composition data in the Tok West and Tok Central survey areas (Table 1). Calf recruitment was poor, ranging between 10–21 calves:100 cows. Calf survival to 5 months has been poor (≤23:100) since 1998. Composition data collected during the population estimation surveys indicate cows with calves selected areas away from the large concentrations of moose. In 1999 the calf:cow ratio was 42 calves:100 cows in the low strata compared to 12 calves:100 cows in the high strata. Calf:cow ratios may be underestimated if based entirely on results collected from traditional trend count areas, which were selected on the basis of high moose density.

The Unit 20E bull:cow ratio remained above the management objective, but was declining in portions of the unit. The number of hunters has increased since 1992 and access into Unit 20E increased as new trails and landing areas were pioneered. In the most popular hunting areas (Nine Mile Trail, Mitchell's Ranch, and along the Yukon River and Taylor Highway) bull populations declined most noticeably, but still met or exceeded the management objective of 40:100. The bull:cow ratio in the Nine Mile Trail area declined to 27:100 by 1992 due to harvest but subsequently increased to about 40 bulls:100 cows by 1999, probably because of access restrictions enacted in 1993. Access into much of Unit 20E continues to be difficult but moose hunters are beginning to find more of the moose concentration areas and the effects of harvest is becoming more noticeable unitwide.

Modeling data indicates that if calf recruitment remains below 30 calves:100, the bull:cow ratio will decline with current harvest levels. Even with hunting season and access restrictions, I

expect the bull population to decrease and the bull:cow ratio to decline below 50 bulls:100 cows in many areas of the unit by 2005.

The long-term calf survival trend in Unit 20E is as follows. The average calf:cow ratios increased from 12.7:100 during 1973–1981 to 19.3:100 during 1982–1988, and 28.7:100 during 1989–1993. Average calf ratios declined to 21:100 between 1994 and 1999 and 15:100 during 2000 and 2001. The increase in calf survival during 1982–1993 was attributed to several factors, including a possible decline in the grizzly bear population in the central part of the subunit (Boertje et al. 1985). In contrast, the grizzly bear population in the eastern portion of the subunit was lightly harvested and probably remained stable. If reducing bear numbers by harvest reduced bear predation on calves, there may have been a difference in calf recruitment between the areas that received high versus low bear harvests. I analyzed this data for 1981–1997 (Gardner 1999) and found no significant difference in calf recruitment between the 2 areas. However, the area of low bear harvests was extensively burned and had a much higher moose density, possibly because of decreased efficiency of predators (Boertje et al. 1985). Since 1997, grizzly bear harvest has been within sustainable levels throughout the unit.

Distribution and Movements

Moose are distributed throughout Unit 20E below elevations of 4500 feet. Most radiocollared moose moved seasonally from lowland summer habitat to upland rutting areas, where they remained until winter conditions caused them to move back to lower elevations. In fall 1988, 1992, 1999, and 2000 early deep snowfall (>22 inches) caused moose to move to lower elevations during November. During 1995 and 1998, low snowfall allowed moose to remain at higher elevations until at least January.

MORTALITY

Harvest

Season and Bag Limit.

RY99–RY00

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 20E, in the Ladue River Controlled Use Area.		
1 bull per regulatory year, only as follows:		
1 bull with spike-fork antlers.	15 Aug–28 Aug	
1 bull.	1 Sep–15 Sep	
1 bull by drawing permit only.	1 Nov–30 Nov	

Units and Bag Limits	Resident Open Season	Nonresident Open Season
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.		5 Sep–15 Sep
Unit 20E, that portion draining into the Yukon River upstream from and including the Charley River drainages to and including the Boundary Creek drainages and the Taylor Highway from mile 145 to Eagle.		
RESIDENT HUNTERS: 1 bull with spike-fork antlers.	15 Aug–28 Aug	
1 bull.	5 Sep–25 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.		5 Sep–25 Sep
Remainder of Unit 20E		
RESIDENT HUNTERS: 1 bull with spike-fork antlers.	15 Aug–28 Aug	
1 bull.	1 Sep–15 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.		5 Sep–15 Sep

RY01

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 20E, that portion within the Ladue River Controlled		

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Use Area.		
RESIDENT HUNTERS: 1 bull per regulatory year, only as follows:		
1 bull by registration permit only.	24 Aug–28 Aug 8 Sep–17 Sep	
1 bull by drawing permit only.	1 Nov–30 Nov	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side by registration permit.		8 Sep–17 Sep
Unit 20E, that portion draining into the Yukon River upstream from and including the Charley River drainages to and including the Boundary Creek drainages and the Taylor Highway from mile 145 to Eagle.		
RESIDENT HUNTERS: 1 bull by registration permit only	24 Aug–28 Aug 5 Sep–25 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side by registration permit only		5 Sep–25 Sep
Unit 20E, that portion draining into the Middle Fork of the Fortymile River upstream from the drainage of the North Fork of the Fortymile River.		
RESIDENT HUNTERS: 1 bull.	24 Aug–28 Aug 8 Sep–17 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow		8 Sep–17 Sep

Units and Bag Limits	Resident Open Season	Nonresident Open Season
tines on at least 1 side.		
Remainder of Unit 20E		
RESIDENT HUNTERS: 1 bull by registration permit only	24 Aug–28 Aug 8 Sep–17 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side by registration permit only.		8 Sep–17 Sep

Alaska Board of Game Actions and Emergency Orders. During the spring 2000 meeting, the Board of Game created a registration permit hunt in Unit 20E, excluding the Middle Fork Fortymile River. The board also split the moose season into 2 periods: 24–28 August and 8–17 September, except within the Yukon River drainage where the season became 24–28 August and 5–25 September. The board made it a stipulation of the registration permit that a hunter had to choose to hunt either moose or caribou. Also during spring 2000, the board set the intensive management population and harvest objectives for the Unit 20E moose population within the Fortymile and Ladue River drainages as 8000–10,000 moose and 500–1000 harvested. During the spring 2002 meeting, the board reduced the season length within the Yukon River drainage to match the season in the remainder of Unit 20E (24–28 Aug and 8–17 Sep). The board also eliminated the grizzly bear trophy tag requirement in Unit 20E excluding the Yukon-Charley Rivers National Preserve with the objective of harvesting more bears to benefit moose calf survival.

Hunter Harvest. During RY99–RY01 the reported fall harvest in Unit 20E ranged between 131 and 138 bulls (Table 2) or about 2.7% of the 2001 estimated early winter population. The average reported harvest for the last 5 years (RY97–RY01) was 140 (131–150), a 27% increase from the previous 5 years (RY92–RY96). Higher harvests and participation rates began in RY91. Greater participation and harvest by nonlocal residents explains most of the increase. Probable causes for the higher harvest were 1) hunters were displaced by stricter regulations throughout Southcentral Alaska, especially in nearby Unit 13; 2) the Fortymile caribou season was open concurrently with the moose season, which attracted hunters interested in hunting both species simultaneously; 3) maintaining a 1 bull bag limit with relatively liberal season dates gave hunters a false impression about the number of moose in the area; and 4) more hunters came to the area looking for large antlered bulls.

The Board of Game created 2 winter drawing permit hunts (DM794 and DM796) within the Ladue River Controlled use area in spring 1994. The harvest objective was to allow greater hunting opportunity in an area that supported a high number of bulls (bull:cow ratio >60:100) but was rarely hunted due to difficult access during the fall. The hunts were managed so winter harvest would not affect the bull numbers in areas commonly hunted during the fall.

During RY95–RY99, 10 winter permits were offered annually for DM794. Due to the low number of permits and difficult access, harvest was 0–4 bulls annually. Even though harvest was low it was concentrated in areas that were hunted during the fall because of easier access. Many unit hunters voiced concern that the winter harvest was affecting local moose numbers. In response, the number of permits was reduced to 8 in 2000 and to 6 in 2001. During 2001, 5 of the 6 permit recipients participated and all were successful. Harvest was again concentrated in areas hunted during the fall and the number of permits was reduced to 3 for RY02. The DM794 hunt area does not lend itself for subdivision to distribute hunters into areas not hunted during the fall. Reducing the number of permits to 3 should limit any impacts on moose numbers in this area regardless of where harvest occurs. I plan to continue to encourage hunters to travel to the more remote areas and attempt to harvest large, trophy bulls (antlers ≥60 inches) that are not accessible in the fall.

During RY95–RY98, 50 winter permits were offered annually for DM796. Access into the central portion of this area is difficult but the southern and northern portions are readily accessible by several snowmachine trails. Moose hunters used these trails extensively in the fall. During the first 2 seasons (RY95 and RY96) only 4 bulls were taken each year. There was no impact on bull numbers. During RY97 and RY98, 14 (35 hunters) and 10 (20 hunters) bulls were taken and harvest was concentrated along the 2 trails used extensively by hunters during the fall hunt. This level of harvest reduced the number of large bulls along these trails.

During RY99 we attempted to reduce the winter harvest of moose along these trails by reducing the number of DM796 permits to 35 and by requesting that all DM796 permit recipients consider hunting more remote areas. The harvest was 8 bulls and half were taken in more remote areas. During RY00 the number of DM796 permits was reduced to 25 and use of the 2 most popular trails into the area was prohibited. Fifteen hunters participated, taking 9 bulls, 6 of which were taken in remote areas.

Historically, most hunters accessed the DM796 hunt area by snowmachine and the 2 best trails to access the remote areas were the 2 that were closed in RY00. In RY01 we established a hunt area within the permit area but allowed any method of legal access including use of all trails. Because the hunt area was more confined, the number of permits was reduced to 10 to guard against an overharvest. During RY01, 7 hunters participated taking 3 bulls. To ensure against DM796 affecting moose numbers, the required hunt area will be changed every 2 years but will be located away from areas most hunted in the fall.

In spring 1994 the board extended the Unit 20E moose season to include an early August season for spike-fork bulls. During RY95–RY98, the season dates were 20–28 August. Only 0–1 spike-fork bulls were harvested annually. The season was extended to 15–28 August during RY99 and RY00 but harvest remained at 0 and 1 spike-fork bulls, respectively. The August spike-fork season was eliminated in RY01 and was replaced by a 5-day any bull season.

Of the 131 and 135 moose harvested during the general season in RY99 and RY00, 33 and 44 (26% and 33% of the harvest) were taken in the Mosquito Fork and 22 and 24 (17% and 18% of the harvest) were taken in the Dennison drainages. In northern Unit 20E, 34 moose (27% and 26% of the harvest) were taken along the Yukon, Charley, and Seventymile Rivers. The combined take in these 5 drainages was 70% of the annual harvest in RY99 and 77% in RY00.

Traditionally, 60–70% of the annual harvest comes from these 5 drainages and the remainder of the harvest is usually spread out across the subunit. Since 1992 the Ladue River drainage is becoming more popular and 7–17% of the fall harvest is coming from that area.

During RY99, RY00, and RY01 the mean antler spread of bulls taken in Unit 20E during the fall hunt was 47.1, 45.8, and 46.3 inches, respectively. The 5-year mean was 46.4 inches. There was no change in average antler size in the harvest during 1987–2001 (P = 0.432) or in the percent antlers ≥50 inches (P = 0.848) or ≥60 inches (P = 0.852). In the RY01 harvest 13 bulls (9.9%) were yearlings (antlers <30 inches), 58 (43.9%) were 2–4 years old (antler spread 30.0–49.9 inches), and 61 (46.2%) were mature bulls (antler spread >50 inches). Of the mature bulls, 14 (11%) had antler spreads >60 inches. Antler spreads were estimated for 297 and 386 bulls observed during posthunting aerial composition surveys in fall 2000 and 2001, respectively. Age composition was 24% and 12% yearlings, 35% and 42% 2- to 4-year-olds, and 41% and 46% mature bulls. Based on RY01 harvest results, hunters did not select for any particular size class. During RY96–RY00 it appeared that hunters either selected against yearlings or yearlings were less vulnerable to harvest than large or medium bulls. Yearlings comprised 7–10% of the harvest but represented 20–25% of the bull population. Spike/forked yearlings were particularly underrepresented in the harvest. Because moose density was low in Unit 20E and most hunters were state residents primarily looking for meat, I doubt many hunters were selective.

Average antler size of moose harvested under DM794 (51.5 inches) and DM796 (55.9 inches) were significantly larger (P = 0.025 and .0003, respectively) compared to the general fall season. Bulls are more concentrated during the permit season allowing hunters to be more selective. Comparing the 2 permit areas, bulls taken in the Prindle Volcano area had larger antlers (P = 0.067).

Antler data also indicates that a 50-inch regulation in Unit 20E would not stop a declining bull:cow ratio. Much of the bull population is comprised of mature bulls that would be vulnerable to harvest. Calf recruitment has been poor since the 1970s resulting in few bulls growing into the 50-inch class each year.

Maintaining a sustainable moose harvest in Unit 20E has become the greatest management challenge in Unit 20E. Our primary concern is the increasing number of hunters. Regulatory changes reduced the chance of high incidental take of moose by caribou hunters but as harvest regulations become more restrictive in other units along the road system more moose hunters are being displaced to Interior units including Unit 20E. Our objective by splitting the season and shortening the season along the Yukon River is to reduce hunter efficiency resulting in lower harvest. If these harvest management methods do not stabilize the harvest, more restrictive regulations will be necessary.

Preliminary data indicate that requiring hunters to hunt either moose or caribou during RY01 caused a reduction in opportunity to incidentally harvest moose. During RY93–RY95, prior to caribou hunting being substantially restricted, 1500–2000 hunters hunted Unit 20E and 12–17% ($\bar{x}$ = 14%) hunted moose and caribou during the same hunt. During 2001, 10% of the hunters hunted both moose and caribou.

Hunter Residency and Success. Of the 131, 135, and 138 bulls harvested during the general season in RY99, RY00, and RY01, 59%, 62% and 64% were taken by nonlocal Alaskan residents. Prior to 1992, most nonlocal hunters were from Interior and Southeast Alaska, but since RY92 most of the nonlocal hunters were from Southcentral Alaska. During RY99-RY01 general season hunts, hunters from Southcentral Alaska represented 39%, 33%, and 35% of the hunters and took 31%, 35%, and 42% of the harvest each year. Local hunters comprised 24–34% of the hunters and took 24–27% of the harvest. Nonresident hunters were prohibited from hunting moose in Unit 20E during RY83–RY90. During RY91–RY96, nonresidents represented 6% of the hunters and accounted for an average of 7% of the harvest. During RY97–RY01, nonresidents represented 8–11% of the hunters and took 8–13% of the harvest.

During RY99–RY01, 562, 522, and 745 hunters reported hunting moose in Unit 20E during the general season (Table 3). The 5-year average was 556. Since RY90 the number of hunters increased significantly ($P = 0.001$). During RY83–RY89 an average of 258 (range = 151–350) persons hunted Unit 20E. Most of the increase was nonlocal hunters, primarily from Southcentral Alaska. The 3 most voiced reasons during informal discussions with Southcentral hunters why they traveled to Unit 20E to hunt were 1) more restrictive regulations in Southcentral units, 2) declining moose numbers in Unit 13, and 3) more opportunity to hunt caribou.

Hunter success was 23%, 26%, and 19% during RY99, RY00, and RY01, respectively. The 5-year average was 26%. During RY99–RY01 success rates of local residents averaged 22% compared with a 22% success rate for nonlocals and 30% for nonresidents. The success rates for local (13%) and nonresidents (22%) were relatively low during RY01.

Harvest Chronology. During RY90–RY94, an average of 35 bulls were harvested during 1–6 September (Table 4) representing 40% (range = 27–50%) of the fall harvest. During RY95–RY00, harvest total during this time period remained the same (36 bulls) but represented only 25% (16–33%) of the harvest. Apparently, as hunter numbers increased in Unit 20E a greater percentage chose to hunt later in the season.

In an attempt to maintain or reduce the fall harvest in Unit 20E, during RY01 the hunting season in most of the subunit was split into 2 periods: 24–28 August and 8–17 September. Our intention was to reduce harvest during the 5-day August season to less than the harvest during the previous 1–5 September season. During RY93–RY00, 16–42 ($\bar{x}$ = 31) bulls were harvested during 1–5 September. In RY01, 14 bulls were harvest during 24–28 August (13–67% reduction).

During RY91–RY98, harvest during 16–25 September in northern Unit 20E was 10–20 bulls annually. Harvest increased to 27–29 bulls during this period in RY99–RY01. The greater harvest was due to more nonlocal Alaska resident hunters. During informal interviews we identified the reason for this increase harvest—the season was open later than anywhere else along the road system. This portion of Unit 20E supports the lowest density of moose (0.3–0.37 moose/mi^2) in the subunit and this increase was not sustainable. Beginning in RY02, the hunting season in northern Unit 20E will be shortened to mirror the season in the remainder of the unit.

Transport Methods. During RY99–RY01, 129, 133, and 138 successful hunters reported the type of transportation used to access Unit 20E. The 3 types most used were 4-wheelers (28–49%),

airplanes (17–24%), and boats (10–21%) (Table 5). There has been little change in transport use since RY95. During RY99–RY01 hunters using highway vehicles had the lowest success rate (8–11%), while hunters using airplanes (31–39%) and ORVs (25–50%) had the highest success rates. Hunters using 4-wheelers had success rates of 24–30%. The success rates in Unit 20E during these 3 years ranged from 19–26%.

In RY94 the number of hunters who used 4-wheelers increased and remained between 120 and 125 through RY98. The number of hunters using 4-wheelers increased to 142–224 during RY99–RY01. During RY92 and RY93 an average of 82 hunters used 4-wheelers. Hunters who used highway vehicles to access the area during the early 1990s began using 4-wheelers or were replaced by hunters using 4-wheelers. During RY99-RY01 hunters using 4-wheelers for access comprised 27–30% of the total hunters. The number of hunters using the other transportation types remained constant. Hunters using 4-wheelers or highway vehicles were responsible for the greatest harvest (Table 5).

In combination with the increasing number of hunters, increasing access is a growing management concern, especially by hunters who use 4-wheelers. The increasing quality and dependability of the machines and the riding ability of the hunters have allowed hunters to access areas that historically have been refugia for moose. This group of hunters tends to have a greater effect on local populations of moose because they tend to concentrate their efforts more than other hunters.

Other Mortality

Predation by wolves and grizzly bears was the greatest source of mortality for moose in Unit 20E and maintained the population at a low density (0.42–0.53 moose/mi^2). Using the model presented by McNay and DeLong (1998), I estimated about 33% of the postcalving moose population was killed by wolves and grizzly bears each year and harvest was about 1.6%. The percentage killed by wolves and grizzles increased during 2000 and 2001 due to an increased wolf population in the central, northern, and eastern portions of the subunit.

HABITAT

Assessment

Availability of browse in Unit 20E is not limiting moose population growth. Recent browse studies found that use of preferred browse plants was less than 5% (Boertje et al. 1985). The greatest expanse of excellent habitat is in the southeastern portion of the subunit resulting from 2 large wildfires (>1,000,000 acres) that occurred during the mid-1960s. This area supports the greatest moose densities in the subunit (about 0.7–1.0 moose/mi^2). Prescribed and wildfires burned over 400,000 acres in Unit 20E during 1998–1999. Moose were using these areas during winter 2001–2002. Habitat quality in these areas is expected to improve during the next 15 years. There are still areas within the northeastern portion of the unit where the habitat has degraded to poor moose habitat due to wildfire suppression activities during the 1970s and 1980s.

Enhancement

The Alaska Interagency Fire Management Plan restored a near-natural wildfire regime to over 60% of Unit 20E. Under the plan, most state and federal land was accorded limited fire

protection. This agreement allowed nearly 300,000 acres to burn naturally during 1998 and 1999. Nearly all land selected by or conveyed to Native corporations was accorded modified or full-suppression status. However, Native corporations in Units 20E and in adjacent Unit 12 have recently consented to allow fire on their land, except in areas where there is marketable timber. More acceptance of fire as a management tool has occurred throughout local communities because of the well-known increase in moose numbers near Tetlin and Tok as a result of the 1990 Tok Wildfire. This change in attitude allowed us to prescribe burn 90,000 acres during 1998 and 1999 in central Unit 20E. These fires were completed within prescription. Costs of the prescribed burns were 35 cents/acre for the 52,000-acre East Fork Burn, 46 cents/acre for the 7000-acre Mosquito Flats burn, and 38 cents/acre for the 31,000-acre Ketchumstuk burn. Moose densities in these areas are expected to increase within 5–15 years.

CONCLUSIONS AND RECOMMENDATIONS

During RY99–RY01 the moose population remained stable or declined slightly and was estimated at 0.42–0.53 moose/mi^2 in fall 2001. Research has shown that predation by wolves and grizzly bears was the primary factor limiting the subunit's moose population. Wolf predation is expected to increase on moose during the next few years. Wolf numbers are increasing in most of Unit 20E because of elevated productivity and survival and relatively low harvest. I recommend both wolf and grizzly bear numbers be reduced if the objective is to substantially increase moose numbers. Reducing either grizzly or wolf numbers would allow the moose population to remain stable or possibly to increase slowly depending on the level of reduction. Combined wolf and bear predation took about 33% of the postcalving moose population annually.

In an attempt to reduce effects of predation on the area's moose population, grizzly bear hunting regulations were liberalized in 1981. As a result, bear harvest increased and possibly caused bear numbers to decline and altered the male age structure toward younger bears. Moose calf survival increased during 1982–1989. Modeling indicated that the reduced bear population may have increased adult moose survival but was inadequate to consistently improve calf survival. We do not know how much a grizzly bear population must be reduced before the predation rate on moose calves will decline substantially. However, modeling predicts the moose population in Unit 20E could grow 8–10% annually if grizzly bear predation rates on calves were reduced 25% in combination with 20–25% wolf harvest by trappers. Beginning in RY02, grizzly bear regulations will be more liberal, allowing resident hunters to incidentally harvest grizzly bears without a $25.00 trophy tag. Because of more liberal caribou hunting regulations, we project that over 2000 hunters will hunt Unit 20E annually during RY02–RY05. If through a public awareness program, grizzly bear harvest increases substantially, it is possible that the bear population will be reduced sufficiently to benefit moose.

Human-induced mortality had little impact on the subunit's moose population but caused some reduction in local bull populations. Annual harvest rates were historically less than 2% of the fall population estimate but increased above 2% in RY95 and has been about 2.5–2.7% during RY97–RY01. The bull:cow ratio declined in portions of Unit 20E due to moderate harvest rates in more accessible areas.

The number of moose hunters in Unit 20E increased significantly ($P = 0.001$) since RY91. Most of the additional hunters were from Southcentral Alaska. The preferred transportation type became 4-wheelers. Twenty-eight percent of the hunters used 4-wheelers to gain access and they took 28–49% of the harvest.

Regulation changes in RY01 appeared to reduce harvest success and stabilize harvest. Harvest declined by 13–67% during a 5-day hunt in August compared to harvest during the first 5 days when the season opened 1 September. Initial results indicated the primary cause of the reduced harvest was fewer hunters participating during the August season. Requiring hunters to choose either to hunt moose or caribou appeared to reduce the incidental take of moose by caribou hunters. During the first year under this regulation fewer hunters (29%) took the opportunity to hunt both moose and caribou compared to RY93–RY95. To further reduce hunters in northern Unit 20E, the moose season will be shortened and will mirror the season in the remainder of the subunit, 24–28 August and 8–17 September beginning in RY02.

Increased hunter participation and harvest during the Unit 20E winter drawing permit hunts caused hunt management changes during RY99–RY01. The intent to allow hunters to hunt moose in areas inaccessible in fall was no longer met. In RY99 the number of DM796 permits was reduced but harvest distribution still did not meet the management intent. Additional reductions in permit numbers and hunt area occurred in RY00 but still was insufficient to meet hunt objectives. In RY01 the hunt area was limited to a small portion of the permit area and only 10 permits were offered. Under this scenario, harvest was limited to areas not hunted in the fall. To guard against an overharvest, the hunt area will be moved periodically, based on harvest success and moose population trend. The number of DM794 permits was reduced in RY01 because harvest amount and distribution became a concern.

More community acceptance of fire has occurred during the past 5 years in Unit 20E. During 1998 and 1999, 3 prescribed burns covering about 90,000 acres were completed in areas that traditionally supported high moose densities. In addition, over 300,000 acres were allowed to burn by wildfire in 1999. Under the current Division of Forestry and Bureau of Land Management leadership, the interagency fire management plan has a great chance of benefiting wildlife and people.

The Unit 20E moose goals and objectives were met during this report period. Population trends were monitored and necessary changes to hunt structure were implemented. Habitat enhancement programs were designed and will be presented to the Interagency Fire Team for possible implementation. Hunting seasons and bag limits were established that allowed maximum hunting opportunity and met subsistence needs. Moose-watching opportunities were shared with visitors and local residents and several oral presentations were given annually to local schools and tourist groups. The intensive management objectives were not met. Changes in grizzly bear harvest regulations were made to increase bear harvest and possibly increase moose calf survival. Before the intensive management objectives can be met, wolf and grizzly bear predation must be reduced.

LITERATURE CITED

BOERTJE RD AND CL GARDNER. 1999. Reducing mortality on the Fortymile caribou herd. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Research Progress Report. Grant W-27-2. Study 3.43. Juneau, Alaska.

———, WC GASAWAY, SD DUBOIS, DG KELLEYHOUSE, DV GRANGAARD, DJ PRESTON, AND RO STEPHENSON. 1985. Factors limiting moose population growth in Game Management Unit 20E. Alaska Department Fish and Game. Federal Aid in Wildlife Restoration. Research Progress Report. Grants W-22-3 and W-22-4. Job 1.37R. Juneau, Alaska.

———, ———, DG KELLEYHOUSE, AND DV GRANGAARD. 1988. Predation on moose and caribou by radiocollared grizzly bears in east-central Alaska. *Canadian Journal of Zoology* 66:2492–2499.

———, DG KELLEYHOUSE, AND RD HAYES. 1996. Methods for reducing natural predation on moose in Alaska and Yukon: an evaluation. Pages 505–514 *in* LN Carbyn, SH Fritts, and DR Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Edmonton.

GARDNER C. 1998. Unit 20E moose management progress report of survey–inventory activities. Pages 330–344 *in* MV Hicks, editor. Alaska Department Fish and Game. Federal Aid in Wildlife Restoration. Grants W-24-4 and W-24-5. Study 1.0. Juneau, Alaska.

———. 1999. Unit 20E grizzly bear management progress report of survey–inventory activities. Pages 211–234 *in* MV Hicks, editor. Alaska Department Fish and Game. Federal Aid in Wildlife Restoration. Grants W-24-5 and W-27-1. Study 4.0. Juneau, Alaska.

GASAWAY WC, RD BOERTJE, DV GRANGAARD, DG KELLEYHOUSE, RO STEPHENSON, AND DG LARSEN. 1992. The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. *Wildlife Monographs* 120.

———, SD DUBOIS, DJ REED, AND SJ HARBO. 1986. Estimating moose population parameters from aerial surveys. Biological Paper 22. University Alaska Fairbanks.

MCNAY ME AND RA DELONG. 1998. Development and testing of a general predator-prey computer model for use in making management decisions. Alaska Department Fish and Game. Federal Aid in Wildlife Restoration. Research Final Report. Grants W-24-1 and W-24-5. Study 1.46. Juneau, Alaska.

SCHWARTZ CC AND AW FRANZMANN. 1989. Bears, wolves, moose, and forest succession, some management considerations on the Kenai Peninsula, Alaska. *Alces* 25:1–11.

STOCKS BJ, BD LAWSON, ME ALEXANDER, EE VAN WAGNER, RS MCALPINE, TJ LYNHAM, AND DE DUBE. 1989. The Canadian forest fire danger rating system: an overview. *Forestry Chronicle* 65:450–457.

VER HOEF JM. 2001. Predicting finite populations from spatially correlated data. 2000 Proceedings of the Section on Statistics and the Environment of the American Statistical Association. pp 93–98.

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Table 1 Unit 20E aerial moose composition counts, fall 1988–2001

Year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1988[a]	78	13	22	117	11	931	1048[a]	30
1989[b]	56	11	43	43	21	158	201	22
1990[b]	64	9	30	105	16	566	671	30
1991[b]	65	14	28	120	14	714	834	42
1992[c]	59	11	17	19	12	141	160	
1992[d]	75	15	28	32	14	200	232	
1993[b]	63	10	28	126	15	727	854	40
1994[c]	74	16	23	65	12	488	553	48
1995[e]	70	16	15	29	8	329	358	
1996[f]	61	10	19	44	10	377	421	
1996[b]	56	6	27	47	15	270	317	45
1997[b]	61	14	26	70	14	438	508	49
1998[g]	64 (53)[h]	18 (10)[h]	19 (23)[h]	36	13	242	278	
1998[i]	59 (51)[h]	14	23 (26)[h]	67	15	383	450	
1999[g]	80 (74)[h]	16 (17)[h]	22 (14)[h]	27	7	338	365	
1999[b]	54	13	17	38	10	340	378	60
2000[g]	60	11	14	44	8	517	561	
2000[i]	49	11	21	37	11	310	347	
2001[g]	76	9	14	38	7	493	531	
2001[i]	51	6	10	39	6	585	624	

[a] Mosquito Flats Study Area sampled using stratified random sampling (Gasaway et al. 1986).
[b] Various trend count areas were sampled using contour sampling.
[c] Mosquito Flats Study Area sampled using superstratification sampling.
[d] Ladue River Study Area sampled using superstratification sampling (Mark McNay, ADF&G, personal communication).
[e] Mosquito Flats Study Area sampled using prestratification sampling (Jay Ver Hoef and Rod Boertje, ADF&G, personal communication).
[f] Ladue River Study Area sampled using prestratification sampling (Jay Ver Hoef and Rod Boertje, ADF&G, personal communication).
[g] Tok West sampled using spatial sampling (Ver Hoef 2001).
[h] Number in parenthesis is the observed ratio.
[i] Tok Central sampled using spatial sampling (Ver Hoef 2001).

Table 2 Unit 20E moose harvest and accidental death, regulatory years 1990–1991 through 2001–2002

Regulatory year	Harvest by hunters							Drawing permit hunts		Accidental death		
	Reported				Estimated							
	M (%)	F (%)	Unk	Total	Unreported	Illegal	Total	DM794	DM796	Road	Total	Total
1990–1991	46 (100)	0 (0)	0	46	0–5	5–15	9–22			0	0	54–61
1991–1992	90 (99)	0 (0)	1	91	0–5	5–15	9–22			0	0	100–113
1992–1993	68 (99)	0 (0)	1	69	0–5	5–15	9–22			1	1	79–92
1993–1994	128 (99)	0 (0)	1	129	0–5	5–15	5–20			0	0	134–149
1994–1995	93 (99)	0 (0)	1	94	0–5	5–15	5–20			0	0	99–114
1995–1996	139 (99)	0 (0)	1	140	0–5	5–10	5–15	0	4	0	0	149–159
1996–1997	116 (99)	0 (0)	1	117	0–5	5–10	5–15	2	4	0	0	128–138
1997–1998	144 (99)	1 (1)	0	145	0–5	5–10	5–15	4	14	0	0	168–178
1998–1999	145 (96)	0 (0)	5	150	0–5	5–10	5–15	1	10	0	0	166–176
1999–2000	127 (97)	0 (0)	4	131	0–5	5–10	5–15	3	9	0	0	148–158
2000–2001	135 (100)	0 (0)	0	135	0–5	5–10	5–15	2	6	0	0	148–158
2001–2002	137 (99)	0 (0)	1	138	0–5	5–10	5–15	5	3	0	0	151–161

Table 3 Unit 20E moose hunter residency and success during the general season, regulatory years 1990–1991 through 2001–2002

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total[b]	(%)	Local[a] resident	Nonlocal resident	Nonresident	Total	(%)	
1990–1991	16	28		46	(16)	65	176	2	249	(84)	295
1991–1992	34	54	3	91	(21)	112	219	9	343	(79)	434
1992–1993	15	45	4	69	(24)	52	135	9	220	(76)	289
1993–1994	38	77	14	129	(30)	93	188	17	300	(70)	429
1994–1995	27	58	9	94	(19)	97	272	17	393	(81)	487
1995–1996	36	93	9	140	(31)	72	208	34	318	(69)	458
1996–1997	40	70	7	117	(29)	97	165	24	286	(71)	403
1997–1998	42	85	18	145	(30)	112	189	31	332	(70)	477
1998–1999	47	91	12	150	(32)	76	205	39	322	(68)	472
1999–2000	36	77	17	131	(23)	98	299	30	431	(77)	562
2000–2001	36	84	15	135	(26)	98	255	33	387	(74)	522
2001–2002	33	88	16	138	(19)	222	323	58	607	(81)	745

[a] Residents of Unit 12 and Units 20E and eastern 20D are considered local residents. Major population centers are Eagle, Chicken, Boundary, Northway, Tetlin, Tok, Tanacross, Slana, and Dot Lake.

[b] Difference in total and sum of residency categories equals numbers with unknown residency.

Table 4 Unit 20E moose harvest chronology by month/day during the general hunt, regulatory years 1990–1991 through 2001–2002

Regulatory year	Harvest chronology by month/day						Total[a]
	8/15–8/27	9/1–9/6	9/7–9/13	9/14–9/20	9/21–9/27	9/28–10/5	
1990–1991		20	9	7	6	0	46
1991–1992		25	26	22	14	0	91
1992–1993		29	28	5	5	0	69
1993–1994		52	40	24	8	0	129
1994–1995		47	21	16	8	0	94
1995–1996	0	46	58	27	3	0	140
1996–1997	1	33	49	23	6	0	118
1997–1998	1	48	50	36	6	0	144
1998–1999	0	35	78	23	6	2	150
1999–2000	0	30	57	28	13	0	131
2000–2001	1	22	61	41	8	0	135
2001–2002	14	0	71	43	7	0	138

[a] Difference between total and summation of harvests by week represents moose taken on unknown dates.

Table 5 Unit 20E moose harvest and percent by transport method during the general season, regulatory years 1990–1991 through 2001–2002

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1990–1991	7 (15)	3 (7)	10 (22)	6 (13)	0 (0)	8 (17)	7 (15)	5 (11)	46
1991–1992	11 (12)	2 (2)	18 (20)	10 (11)	0 (0)	15 (16)	35 (38)	0 (0)	91
1992–1993	17 (25)	1 (1)	4 (6)	21 (30)	1 (1)	7 (10)	15 (22)	3 (4)	69
1993–1994	31 (24)	0 (0)	15 (12)	34 (26)	0 (0)	15 (12)	32 (25)	2 (2)	129
1994–1995	24 (26)	0 (0)	14 (15)	26 (28)	0 (0)	13 (14)	15 (16)	2 (2)	94
1995–1996	29 (21)	0 (0)	19 (14)	39 (28)	1 (1)	16 (11)	34 (24)	2 (1)	140
1996–1997	26 (22)	3 (3)	18 (15)	26 (22)	0 (0)	13 (11)	30 (26)	1 (1)	117
1997–1998	29 (20)	3 (2)	13 (9)	46 (32)	0 (0)	15 (10)	36 (25)	3 (2)	145
1998–1999	32 (21)	0 (0)	23 (15)	40 (27)	1 (1)	12 (8)	41 (27)	1 (1)	150
1999–2000	31 (24)	1 (1)	26 (20)	37 (28)	0 (0)	19 (15)	15 (11)	2 (2)	131
2000–2001	29 (21)	2 (1)	28 (21)	40 (30)	0 (0)	14 (10)	20 (15)	2 (1)	135
2001–2002	23 (17)	0 (0)	14 (10)	68 (49)	0 (0)	15 (11)	18 (13)	0 (0)	138