

MOOSE POPULATION SURVEY

Tetlin National Wildlife Refuge
Game Management Unit 12, eastern Alaska



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Gail H. Collins
W. N. Johnson
Henry K. Timm

U. S. Fish & Wildlife Service
Tetlin National Wildlife Refuge
P. O. Box 779
Tok, Alaska 99780

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ABSTRACT

An aerial moose (*Alces alces*) population survey was completed on Tetlin National Wildlife Refuge and the northeast corner of Game Management Unit (GMU) 12 from 14 November to 18 November 2003. We estimated the population at 1,317 moose for the 7,651 km² (2,954 mi²) survey area. Overall density was 0.17 moose/ km² (0.45 moose /mi²). The estimated ratios of bulls, yearling bulls, and calves per 100 cows were 89.4, 15.3, and 32.8, respectively. Bulls made up 41.1 % of the population, cows 46.0%, and calves 15.1%.

BACKGROUND

A primary purpose of the Tetlin National Wildlife Refuge (Tetlin Refuge) is to conserve the natural diversity of fish and wildlife populations, and habitats. Tetlin Refuge is also responsible for providing subsistence opportunities for local residents. Moose are an integral part of the natural communities of the Upper Tanana Valley and a key component of the annual subsistence harvest of many area residents.

To adequately monitor moose populations that occur within Tetlin Refuge and adjacent areas, estimates of population size and structure need to be generated from data gathered annually. Shortly after Tetlin Refuge was established in 1981, staff began collaborating with the Alaska Department of Fish and Game (ADF&G) to collect information on the local moose population. As early as 1982, trend and composition surveys were conducted on Tetlin Refuge and adjacent areas in GMU 12 using methodology developed by ADF&G to maintain data consistency. The first large-scale moose census to include Tetlin Refuge was completed in the fall of 1990 in cooperation with ADF&G. This census used methods developed by Gasaway et al. (1986) and incorporated a stratified-random sample of an area encompassing Tetlin Refuge, portions of Tetlin Native Corporation lands, and Alaska State lands within GMU 12. In subsequent years, Tetlin Refuge continued to complete trend or composition surveys annually, conditions permitting.

During the fall of 2000, 2001 and 2003, Tetlin Refuge conducted aerial moose surveys encompassing roughly the same area as that surveyed in 1990. These surveys utilized a statistical method called Finite Population Block Kriging that is based on spatial correlation and has been successfully used for estimating and monitoring moose abundance in Alaska and the Yukon (Ver Hoef 2001, 2002). This spatially oriented sampling method has several advantages over classical stratified random sampling: (1) higher precision, (2) provides estimates for smaller areas, and (3) does not require random sampling (Ver Hoef 2001). This method also has a more flexible stratification protocol, making the survey logistically easier to conduct and therefore less expensive. This report summarizes the results from our 2003 survey and makes comparisons between years.

SURVEY AREA

The study area was in east-central Alaska and was bordered to the northeast by the Alaska Highway, to the west and south by the Mentasta and Nutzotin Mountains of the Alaska Range, and to the east by Yukon Territories, Canada (Fig. 1). The 7,651 km² (2,954 mi²) survey area encompassed all of Tetlin Refuge, portions of Wrangell-St. Elias National Park and Preserve (2,149 km²; 830 mi²), and portions of Tetlin Native Corporation Lands (1,787 km²; 690 mi²) (Fig. 1). The survey area comprised about 30% of GMU 12. Using the same methods, ADF&G also annually surveys a 7,549 km² (2,846 mi²) area in GMU 12 adjacent to our study area.

The landscape within the survey area was characterized by large tracts of boreal forest (taiga) interspersed with wetlands typical of much of interior Alaska. As elevation increased, dense spruce gave way to open spruce woodlands mixed with tall shrubs, then dwarf-shrub communities, and finally alpine tundra. Shrubs were most common along streams and water bodies, within recently burned areas, and along gullies that drain subalpine tundra. The latter were most often found above 4,000 ft and tended to concentrate moose during the post-rut periods in fall and early winter. The boreal forest consisted primarily of black spruce (*Picea mariana*) in wet and poorly drained areas and white spruce (*P. glauca*) on drier sites. Quaking aspen (*Populus tremuloides*) often occurred in pure stands on recently burned south-facing slopes. Paper birch (*Betula papyrifera*) and balsam poplar (*P. balsamifera*) occasionally occurred in pure stands or are mixed with spruce. The shrub component was primarily willow (*Salix spp.*), alder (*Alnus spp.*), and dwarf birch (*B. spp.*).

METHODS

The survey area was overlain with a grid of sample units ($n = 482$) defined by two minutes of latitude (north to south) and five minutes of longitude (east to west) (Fig. 2). Each sample unit encompassed approximately 15.8 km² (6.1 mi²). All sample units were stratified into two groups based on expected moose density: low (≤ 1 moose; $n = 384$) or high (≥ 2 moose; $n = 98$). Stratification was developed from reconnaissance flights, previous survey results, and incidental observations by Refuge staff and ADF&G personnel. Eighty sample units (35 low density, 45 high density) were then randomly selected to survey (Fig. 2).

Four pilot / observer teams flew fixed-wing aircraft (Piper PA-18 SuperCub or Aviat Husky) to classify and count moose within selected sample units. Sample units and their respective boundaries were located using the aircraft's Global Positioning System (GPS). In flat terrain we generally flew 10 - 12 transect lines ca. 300 meters apart. In more mountainous areas, the terrain often dictated that we follow contours. We strove to spend approximately 30 to 35 minutes searching each unit (ca 2.0 minutes/km² or 5.5 minutes/mi²). Heavily forested units generally required more search time while open areas and barren mountain ridges required less time.

Observed moose were classified based on antler size and morphology as: large bull, medium bull, yearling bull, cow, or calf. A geostatistical spatial analysis (ADF&G Moose Survey Population Software; Ver Hoef 2001, 2003, 2004) and the software program MOOSEPOP (Reed 1989) were used to estimate moose abundance, density, and age and sex ratios.

RESULTS AND DISCUSSION

Approximately 17% of the total survey area was surveyed from 14 November to 18 November 2004. This included 46% of the stratum classified as high and 9% of the stratum classified as low (Table 1, Fig. 2). Overall, weather was seasonally average with ground temperatures ranging from -32° to -10°F and snow cover was adequate throughout most of the survey area by early November. Survey conditions were consistent with the protocol. Total survey time was 40.9 hours with an average of 30.7 min/sample unit. The mean survey intensity was 1.9 min/km² (5.0 min/mi²), comparable with previous years (Table 1). No incidental observations of wolves (*Canis lupus*) or wolf sign were made during the survey.

We accurately stratified 84% of all surveyed sample units (82% high strata, $n = 37$; 86% low strata, $n = 30$). Because we rely in part on our experience from past surveys to help stratify the survey units, we presume that over time our accuracy would improve as we became more familiar with the survey area. However, several factors can affect stratification accuracy between years including pockets of habitat along unit boundaries, movement between units, and predator avoidance. Consequently, some variability between years is likely.

The 2003 population estimate for the survey area was 1,317 moose (range = 1,065 – 1,569, 90% C.I.) (Table 2, Fig. 3). Overall moose density was estimated at 0.17 moose/km² (0.45 moose/mi²). Within the high and low strata, density was 0.64 moose/km² (1.67 moose/mi²) and 0.02 moose/km² (0.06 moose/mi²), respectively. The estimated density of moose was comparable to both the 1990 and 2001 estimates. Moose densities < 1.0 moose/mi² are considered to be low (Gasaway et al. 1992).

The ratio of calves:100 cows was 32.8, consistent with estimates since 2000 (Table 2), and continues to be higher than average ratios estimated during historical trend surveys ($\bar{x} = 28.9$, 1987-1998; Table 3). The average calf:cow ratio for identified low density (< 1.0 moose/mi²) moose populations is 26.4 calves:100 cows ($n = 20$, range = 6 - 54; Gasaway et al. 1992). For identified high density (>1.0 moose/mi²) moose populations, the average calf:cow ratio is 33.8 calves:100 cows ($n = 16$, range = 20 – 47; Gasaway et al. 1992).

Recruitment, as indicated by the ratio of yearling bulls:100 cows, was estimated at 15.3 in 2003, also consistent with both 1990 and 2001 estimates. All three estimates are

appreciably higher than estimates in 2000 (9.5 yearling bulls:100 cows), and slightly lower than the historical average for trend surveys ($\bar{x}$ = 17.2; Table 3). In general, recruitment can be highly variable among years due to changes in predation levels, habitat, and weather conditions (Yukon Renewable Resources 1996).

The bulls:100 cows ratio was estimated to be 89.4 in 2003, appreciably higher than estimates in 1990, 2000, and 2001, but comparable to historical trend averages ($\bar{x}$ = 90.0; Table 3). The area included in this survey is less accessible than other areas of GMU 12; the majority of the harvest within GMU 12 occurs to the west and north. The high estimated bull:cow ratios continue to reflect observed low harvest rates in this portion of the population.

We observed more moose during this survey than we did in 2000 or 2001 (Table 2). Increases occurred for all classes, resulting in comparable relative proportions of bulls, cows, and calves between years. The population estimate for 2003 was slightly lower than 1990 and 2001, but well within the 90% confidence intervals (Fig. 3). The estimates for 2000 continue to be the lowest reported, although the cause is unknown. Several factors can affect survey results including moose movements, poor stratification, survey conditions, and participant experience.

Given our estimates of moose density, percentage of adult bulls, calf production, and yearling recruitment, the moose population within the survey area appears to be healthy and at a stable density. Although the moose density is considered low, the adult age class structure is diverse, and calf production and recruitment continue to be good.

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Figure 1. Tetlin Refuge moose survey area, eastern Alaska, 2000-2003.

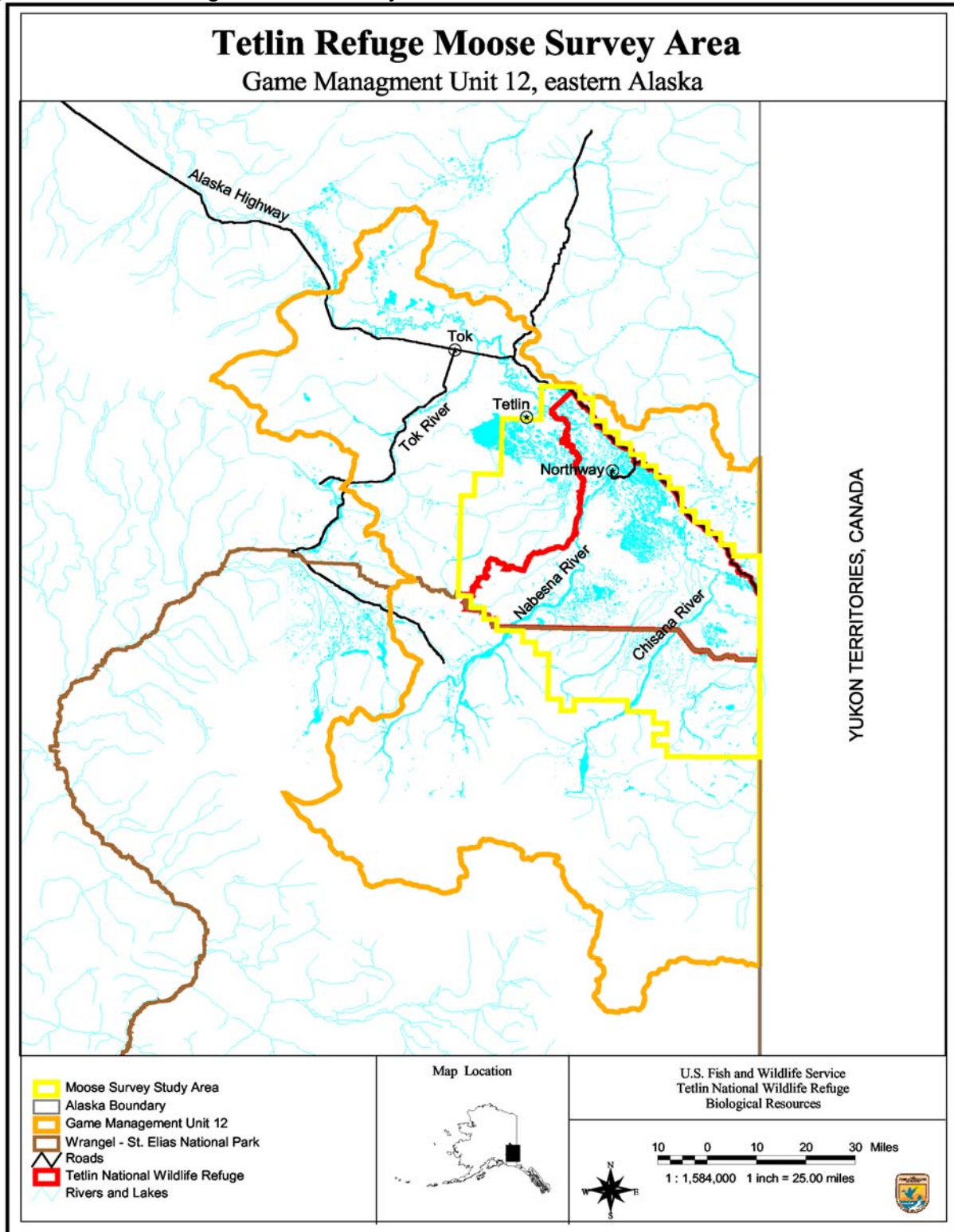


Figure 2. Tetlin Refuge moose survey stratification and randomly selected sample units, eastern Alaska, 2003.

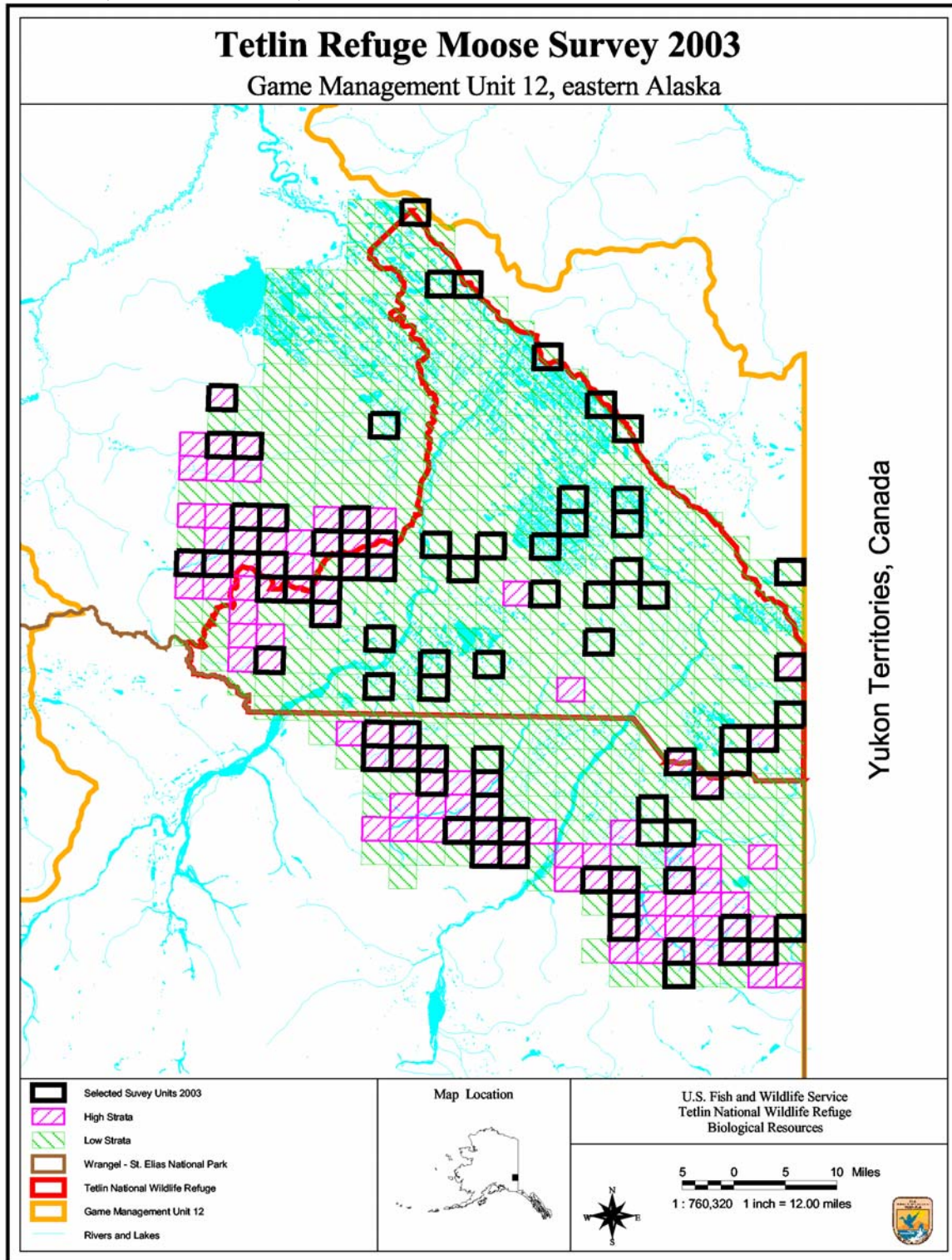
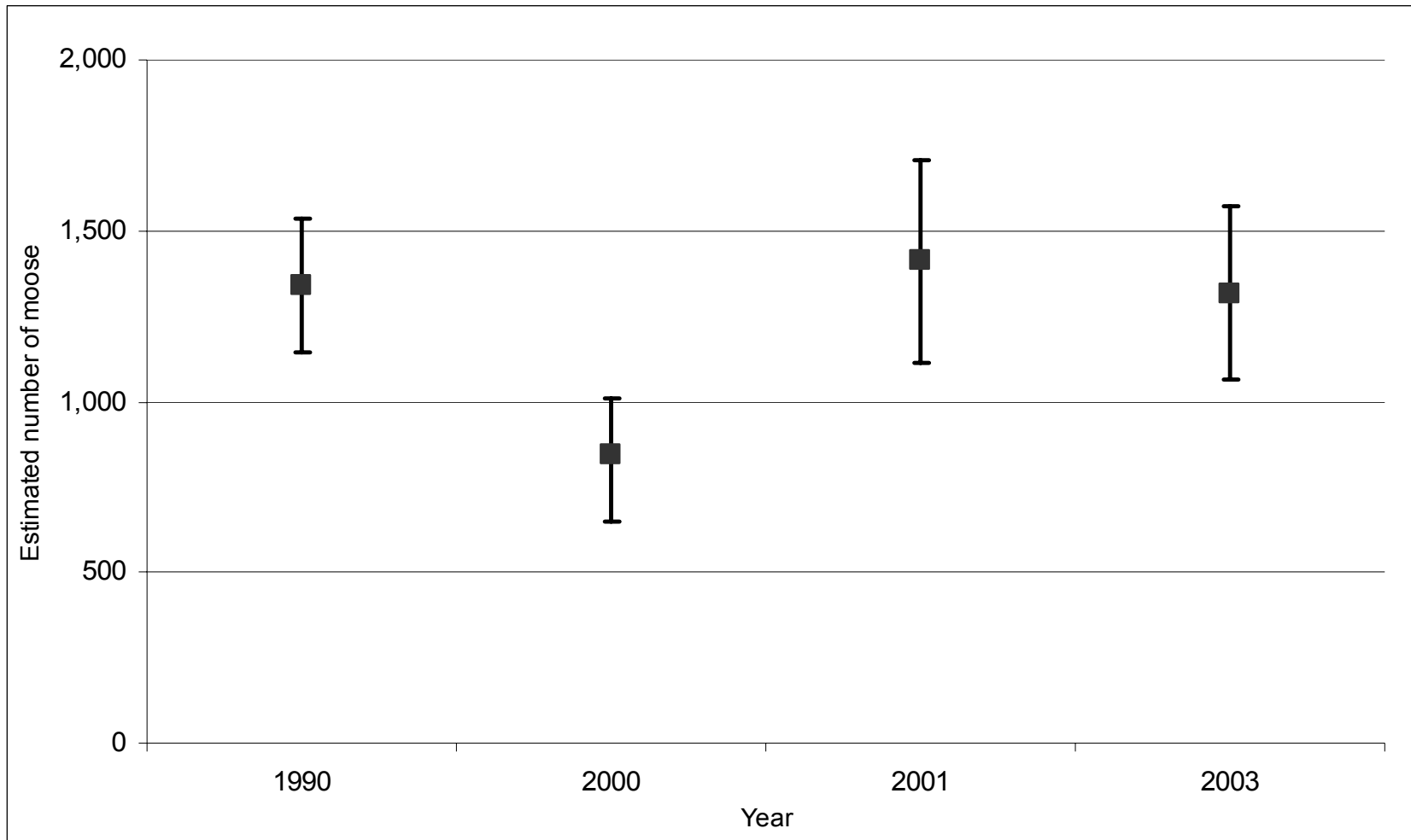


Figure 3. Estimated number of moose and 90% confidence intervals from aerial surveys on Tetlin Refuge and adjacent areas in GMU 12, eastern Alaska, 1990^a and 2000-2003^b.



^aMethodology from Gasaway et al. 1986

^bMethodology from Ver Hoef 2001, 2002

Table 1. Summary of sampling effort for fall moose population surveys conducted on Tetlin Refuge and adjacent areas in GMU 12, eastern Alaska, 1990 and 2001-2003.

	Year							
	1990		2000		2001		2003	
	km ² (mi ²)	% of Area	km ² (mi ²)	% of Area	km ² (mi ²)	% of Area	km ² (mi ²)	% of Area
Total Area	9,583 (3,700)		7,697 (2,972)		7,651 (2,954)		7,651 (2,954)	
Low strata	7,278 (2,810)	75.9%	5,498 (2,123)	71.4%	5,944 (2,295)	77.7%	6,088 (2,350)	79.6%
Medium strata ^a	1,370 (529)	14.3%	--	--	--	--	--	--
High strata	935 (361)	9.8%	2199 (849)	28.6%	1,707 (659)	22.3%	1,564 (604)	20.4%
Total Area Sampled	1,792 (692)	18.7%	1,272 (491)	16.6%	1,272 (491)	16.6%	1,272 (491)	16.6%
Low strata	730 (282)	10.0%	443 (171)	8.1%	544 (210)	9.2%	555 (214)	9.1%
Medium strata ^a	544 (199)	39.7%	--	--	--	--	--	--
High strata	515 (199)	55.1%	829 (320)	37.7%	715 (276)	41.9%	718 (277)	45.9%
Survey Time (hrs)	N/A		39.6		37.9		40.9	
Intensity min/km² (min/mi²)	N/A		1.9 (4.8)		1.8 (4.7)		1.9 (5.0)	

^a The survey conducted in 1990 designated three strata and used methods developed by Gasaway et al. (1986). Subsequent surveys used two strata and spatial analysis (Ver Hoef 2000, 2001).

Table 2. Observed and estimated population parameters from aerial surveys on Tetlin Refuge and adjacent areas in GMU 12, eastern Alaska, 1990 and 2000-2003.

	Year			
	1990	2000	2001	2003
Moose Observed				
Yearling Bulls	49	14	33	30
Medium Bulls	94	44	65	71
Large Bulls	74	43	81	117
Cows with no calves	260	93	159	174
Cows with one calf	48	31	58	76
Cows with two calves	4	4	4	6
Total bulls	217	101	179	218
Total cows	312	128	221	256
Total calves	56	39	66	89
Total moose	585	268	466	563
Population Estimates^a				
Total Moose	1,339	844	1,411	1,317
Moose/km ² (mi ²)	0.14 (0.36)	0.11 (0.28)	0.19 (0.48)	0.17 (0.45)
Moose/km ² (mi ²) Low Strata	0.01 (0.02)	0.03 (0.07)	0.08 (0.21)	0.02 (0.06)
Moose/km ² (mi ²) Medium Strata ^b	0.20 (0.53)	--	--	--
Moose/km ² (mi ²) High Strata	0.85 (2.30)	0.30 (0.79)	0.58 (1.49)	0.64 (1.67)
Percent Cows	43.8	45.7	49.1	46.0
Percent Calves	11.1	15.6	16.3	15.1
Percent Yearling Bulls	8.1	4.3	8.0	7.0
Percent Bulls	28.9	38.6	36.7	41.1
Bulls/100 Cows	71.2	84.4	74.8	89.4
Yearling Bulls/100 Cows	15.4	9.5	16.4	15.3
Calves/100 Cows	21.9	34.0	33.2	32.8

^a All estimates made in 1990 were computed from the program MOOSEPOP (Reed 1989). Following analyses used MOOSEPOP to compute estimates for low and high strata; all other estimates were derived from spatial analysis (Ver Hoef 2001, 2002, 2004).

^b The survey conducted in 1990 designated three strata. The criterion for each stratum (i.e., the predicted moose density) is not known.

Table 3. Moose counts and estimates in four trend areas on and adjacent to Tetlin Refuge, eastern Alaska, 1987-1999.

	Year											Statistics	
	1987	1988	1989	1990	1991	1992	1994	1995	1996	1997	1999 ^a	$\bar{x}$	s.d.
Total moose	425	459	495	497	452	178	421	526	471	512	130		
Cows	211	182	214	222	212	84	190	254	224	235	56		
Adult bulls	125	147	145	175	157	74	159	176	137	153	48		
Yearling bulls	35	54	48	36	41	6	25	31	30	51	13		
Calves	55	75	85	64	42	14	47	65	80	73	13		
Survey time (min)	580	635	675	389	642	792	578	614	737	793	294		
Calves:100 cows	26.1	41.2	39.7	28.8	19.8	16.7	24.7	25.6	35.7	31.1	23.2	28.9	8.1
Yearling bulls:100 cows	16.6	29.7	22.4	16.2	19.3	7.1	13.2	12.2	13.4	21.7	23.2	17.2	6.4
Bulls:100 cows	75.8	110.4	90.2	95.0	93.4	95.2	96.8	81.5	74.6	86.8	108.9	90.0	10.8
Moose/hour	44.0	43.4	44.0	76.7	42.2	13.5	43.7	51.4	38.3	38.7	26.5	43.6	15.3

^aOnly two of four trend areas were completed in 1999; these values were not included in the average and st. dev. calculations.