

2003 AERIAL MOOSE SURVEY,
YUKON-CHARLEY RIVERS NATIONAL PRESERVE, ALASKA
November, 2003
John Burch
Technical Report NPS/AR/NRTR-2004/44



United States Department of the Interior • National Park Service • Alaska Region



The Alaska Support Office

The Alaska Regional Office of the National Park Service is the central administrative office for the 15 areas in Alaska. The diversity of areas and their resources is reflected in their designation as national parks, monuments, preserves, and historical parks. These 15 areas represent over 50% of the total acreage the National Park Service administers. The Alaska Support Office Resource teams direct scientific research and resource management programs in a wide range of biological, physical, and social science disciplines.

The National Park Service disseminates reports on high priority, current resource management information, with managerial application, through the Alaska Region Natural Resource Report Series. Technologies and resource management methods, how-to resource management papers, proceedings of resource management workshops and conferences, and natural resource management plans are also disseminated through this series. Documents in this series usually contain information prepared primarily for internal use within the National Park Service. This information is not intended for use in open literature.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Copies of this report are available from the following. To order from the National Park Service, use the reference number on the reports title page.

National Park Service
Yukon-Charley Rivers National Preserve
201 1st Avenue
Fairbanks, Alaska 99701
907-455-0623

or

National Park Service
Alaska Support Office
2525 Gambell Street
Anchorage, Alaska 99503-2892

2003 AERIAL MOOSE SURVEY,
YUKON-CHARLEY RIVERS NATIONAL PRESERVE, ALASKA

PROJECT REPORT
November, 2003

JOHN BURCH, U.S. National Park Service, Yukon-Charley Rivers National Preserve & Gates of the Arctic National Park and Preserve, 201 1st Avenue, Fairbanks, Alaska 99701.

DATA SUMMARY:

Survey dates: November 15-21, 2003 (5.5 days of survey, 1.5 weather days)

Total area: 3,157 mi² (8,177 km²)

Total moose observed: 159 (87 cows, 17 calves[1 set of twins], 55 bulls [6 spike-fork bulls])

Average search effort: 6.6 minutes/mi² (2.6 minutes/km²)

Population estimate: 696 moose +/-166 (530 – 862) (+/-23.86% at 90% CI)
(375 cows, 94 calves, 227 bulls [24 spike-fork (yrl) bulls])

Estimated density: 0.22 moose/mi² (0.085 moose/km²)

Estimated age/sex ratios: 25 calves:100 cows, 13 yearlings:100 cows, 61 bulls:100 cows

Average harvest: 26 bulls per year (20 year average, preserve wide)

INTRODUCTION

The National Park Service conducted an aerial moose survey during November 15-21, 2003, in Yukon-Charley Rivers National Preserve (YUCH), Alaska (Figure 1). The purpose of this survey was to estimate the moose population size and sex/age composition for the Yukon River corridor within YUCH. Moose population information is needed by preserve and state wildlife managers for monitoring long-term population trends and to make informed decisions regarding proposed changes to moose hunting regulations for this area.

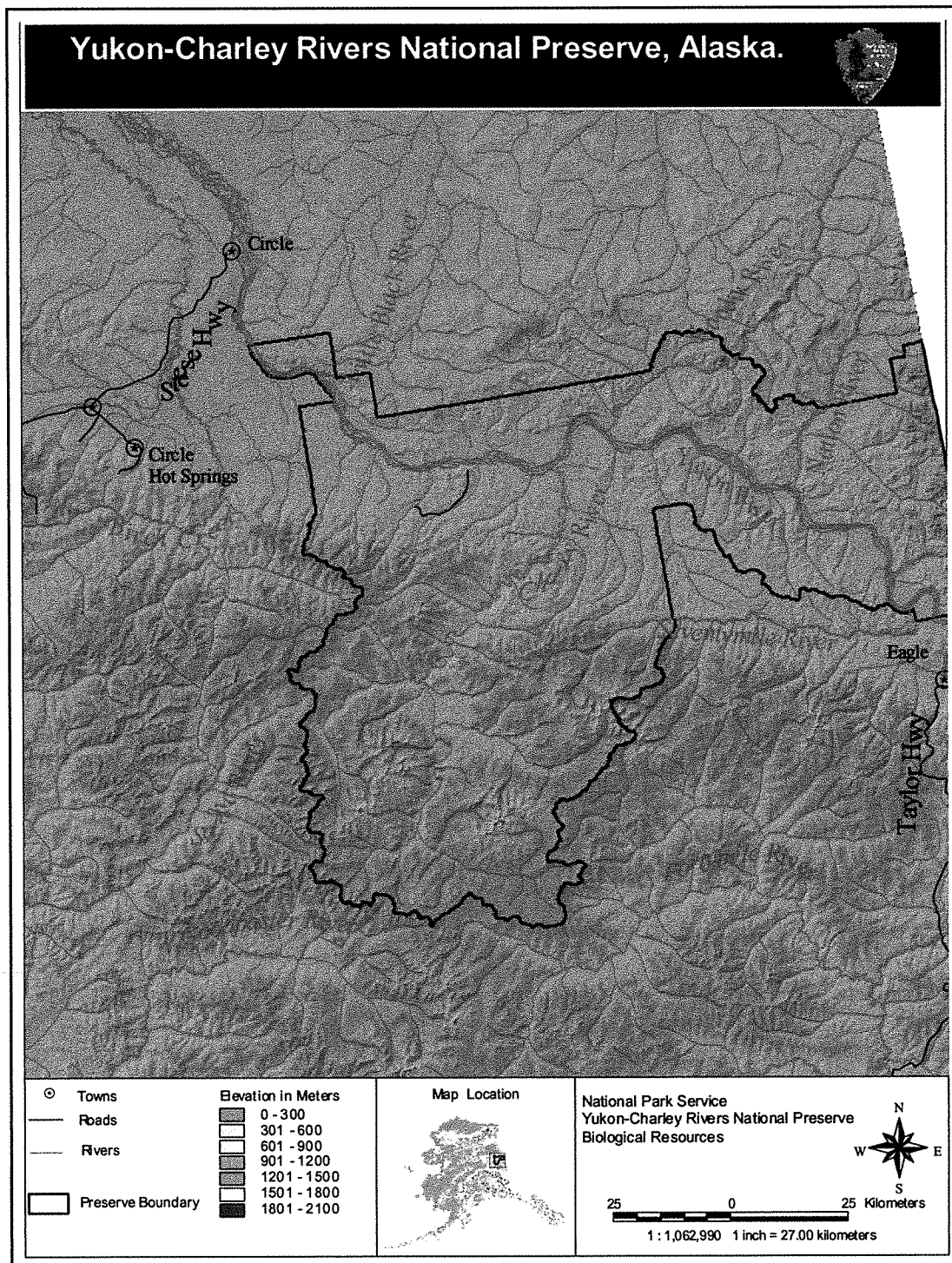


Figure 1. Location of Yukon-Charley Rivers National Preserve (YUCH), Alaska.

Several moose surveys have been conducted within the preserve during the last 25 years. In February 1975, a general survey was conducted along the Yukon River to identify winter habitat (Boertje 1985). During 1982-1987, trend counts were conducted in the Washington Creek area as part of an Alaska Department of Fish and Game (ADF&G) study investigating the role of predation in limiting moose densities in east-central Alaska (Gasaway et al. 1992). In November 1987, a large area along the Yukon River was surveyed between Eagle and Circle within YUCH (Nowlin 1988). A winter, moose habitat-use survey was conducted along the lower Nation River and Hard Luck Creek in March 1991 (Knuckles 1991). The entire Charley River drainage and the Yukon River between Glenn Creek and Woodchopper Creek was surveyed in November 1994 (Demma et al. 1995). The same Yukon River corridor area between Eagle and Circle, surveyed in 1987, was surveyed in 1997 (Burch and Demma 1997) in 1999 (Burch 1999) and again during this survey, thus providing 4 surveys covering the same area that are directly comparable. Sampling methodologies used during past surveys varied. Consequently, the results of the older surveys (1970s, early 1980s, and 1994) are of limited use in determining long-term moose population changes in YUCH. This survey used a geo-spatial estimator (Ver Hoef 2001, Ver Hoef 2002) and the previous 3 surveys all used methods described by Gasaway et al. (1986). All 4 surveys are directly comparable.

In 1998, proposals to change harvest regulations were submitted by local subsistence hunters in Eagle. These proposed changes included a longer fall season and the addition of a March hunting season for qualified federal subsistence users. The longer fall season was adopted, but the March season was not.

In the past, residents of local communities have relied on caribou from the Fortymile Caribou Herd and moose for meat. The total harvest limit for Fortymile Caribou Herd caribou was reduced from 450 to 150 for 1996-2000 as a result of an interagency management plan developed to restore the caribou herd to its former range (ADF&G 1995). The reduction in harvest limits for caribou in the Fortymile Caribou Herd reduced the availability of caribou from this herd for all Alaska residents. Because of this harvest reduction, local residents were more dependent on moose for meat. Harvest opportunity of Fortymile caribou has now increased incrementally beginning in 2001 as outlined in the Fortymile caribou harvest plan (ADF&G, et al 2000) and has likely taken some human harvest pressure off YUCH's moose population. Despite this probable reduction in pressure, local residents have voiced concerns of competing with increasing numbers of non-local hunters for area moose during the general hunting seasons. The issue of subsistence vs. general hunting, and issues related to rural preference for local wildlife resources are controversial statewide. Resource conflicts of this nature will likely intensify as competition increases for limited wildlife resources in Alaska. Information provided by this survey (and others like it in the future) will assist managers in effectively evaluating future proposals regarding moose hunting and the moose population inhabiting YUCH. Regularly recurring fall surveys are crucial to monitoring this moose population. Analysis presented here indicate an increase in moose harvested and an increase in the number of people hunting. This increased harvest pressure is on a low density moose population, with poor recruitment. Past surveys indicate a low density, stable population, but the stability of the population is uncertain. Another survey in fall 2006 or 2007 is recommended.

STUDY AREA

The moose survey was conducted along a 30-40 mile (48-64 km) wide corridor of the Yukon River drainage within YUCH, between Eagle and Circle, Alaska (Figure 2). The topography of the area consists mainly of rolling hills and river bluffs. Some isolated rugged terrain occurs on several eroded mountains, with peaks generally under 6000 feet (1200 meters). Vegetation is dominated by black spruce (*Picea mariana*), and several species of deciduous hardwoods including aspen (*Populus tremuloides*) and birch (*Betula papyrifera*). Ponds, sloughs and large areas of tussock tundra are common in the flats along the Yukon River and lower parts of large tributaries such as the Charley and Kandik Rivers. Wildfire burns of varying sizes and ages are present throughout the study area (NPS 1985) including the more recent large fires from summer 1999 and 2004 along the Yukon, Nation and Kandik rivers. The preserve's fire management plan (NPS 1999) contains a more in depth review of fire history for the area. YUCH's General Management Plan (National Park Service 1985) and an ecological unit mapping report (Swanson 1999) are more thorough descriptions of the vegetation and physiography of the area.

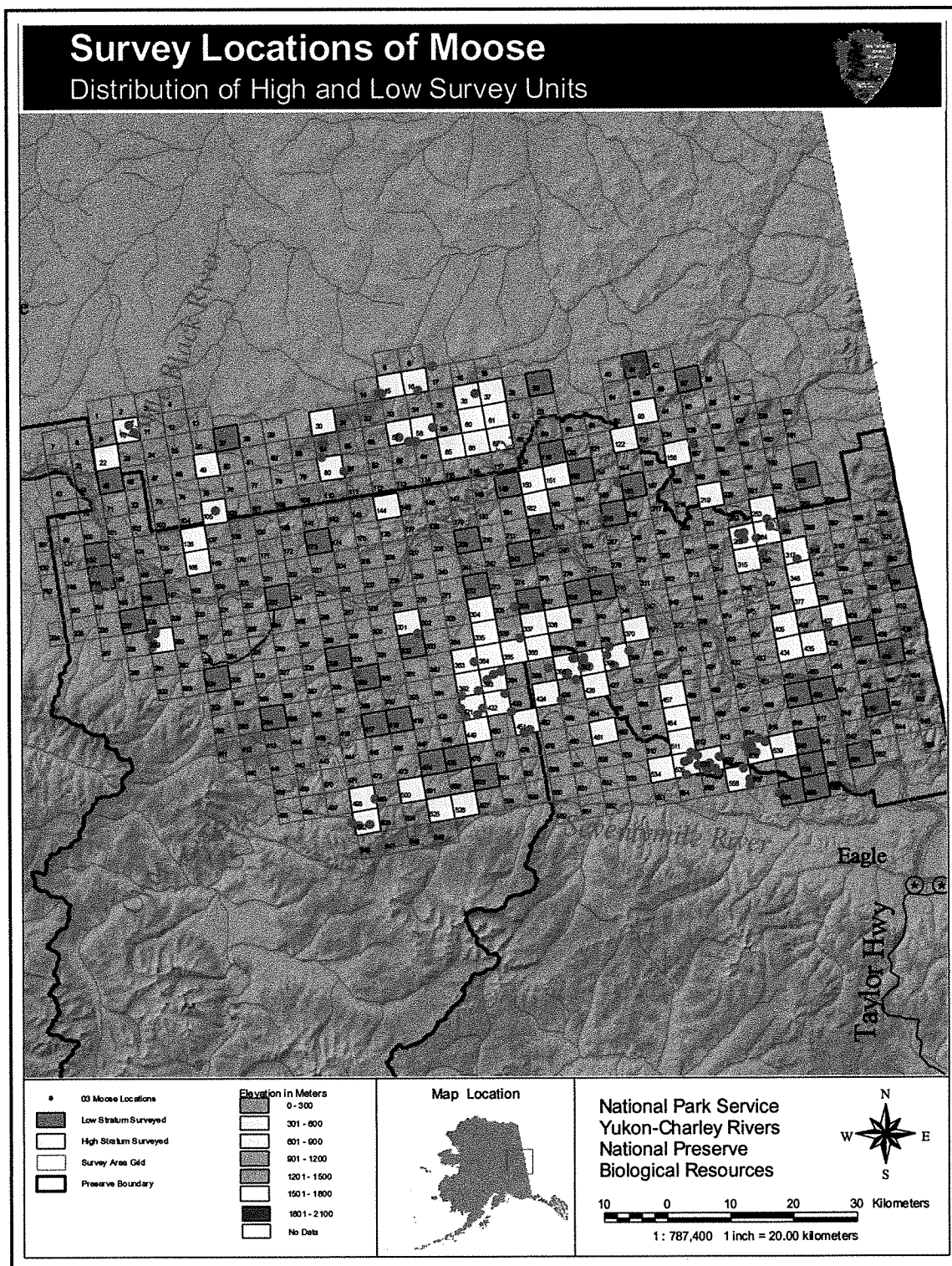


Figure 2. Location of the moose survey area and all survey units (red grid). Location of moose groups observed during the survey are depicted as red dots. Green units were low strata and yellow units were high strata surveyed in November 2003 in Yukon-Charley Rivers National Preserve, Alaska.

METHODS

This survey used methods described by Gasaway et al. (1986) and modified by Ver Hoef (2001). To follow the modifications suggested by Ver Hoef, the study area was reconfigured for this survey into a grid of 566 square survey units. Each survey unit averaged 5.58 mi². Units of this size were delineated by 2 minutes of latitude by 5 minutes of longitude (Figure 3). Sample units were stratified into high (1 or more moose) or low (0 moose) moose densities based on moose locations, locations of wolf-killed moose, and past knowledge from previous surveys.

Stratification flights were not flown during 2003 (Nowlin 1988, Demma et al. 1995, Burch and Demma 1997, Burch 1999). During the survey, up to four pilot/observer teams in Piper PA-18 or Belonca Scout aircraft surveyed sample units at a rate averaging 6.6 minutes per mi² (2.6 minutes/km²). Moose observed were assigned group numbers and mapped by recording coordinates of each moose group observed utilizing the aircraft's Global Positioning System (GPS) receivers. Numbers of moose in each group were recorded and sex and age of each moose was determined. Moose were classified as: cow, calf, yearling bull (spike or forked antlers), medium bull (antler spread > spike/fork, but < 50 inches [127 cm]), and large bull (antler spread ≥50 inches [127 cm]). Total moose, moose density and sex/age ratios were calculated using the software 'SMOOSE' (Ver Hoef 2001) and 'MOOSEPOP' (Gasaway et al. 1986, Reed 1989).

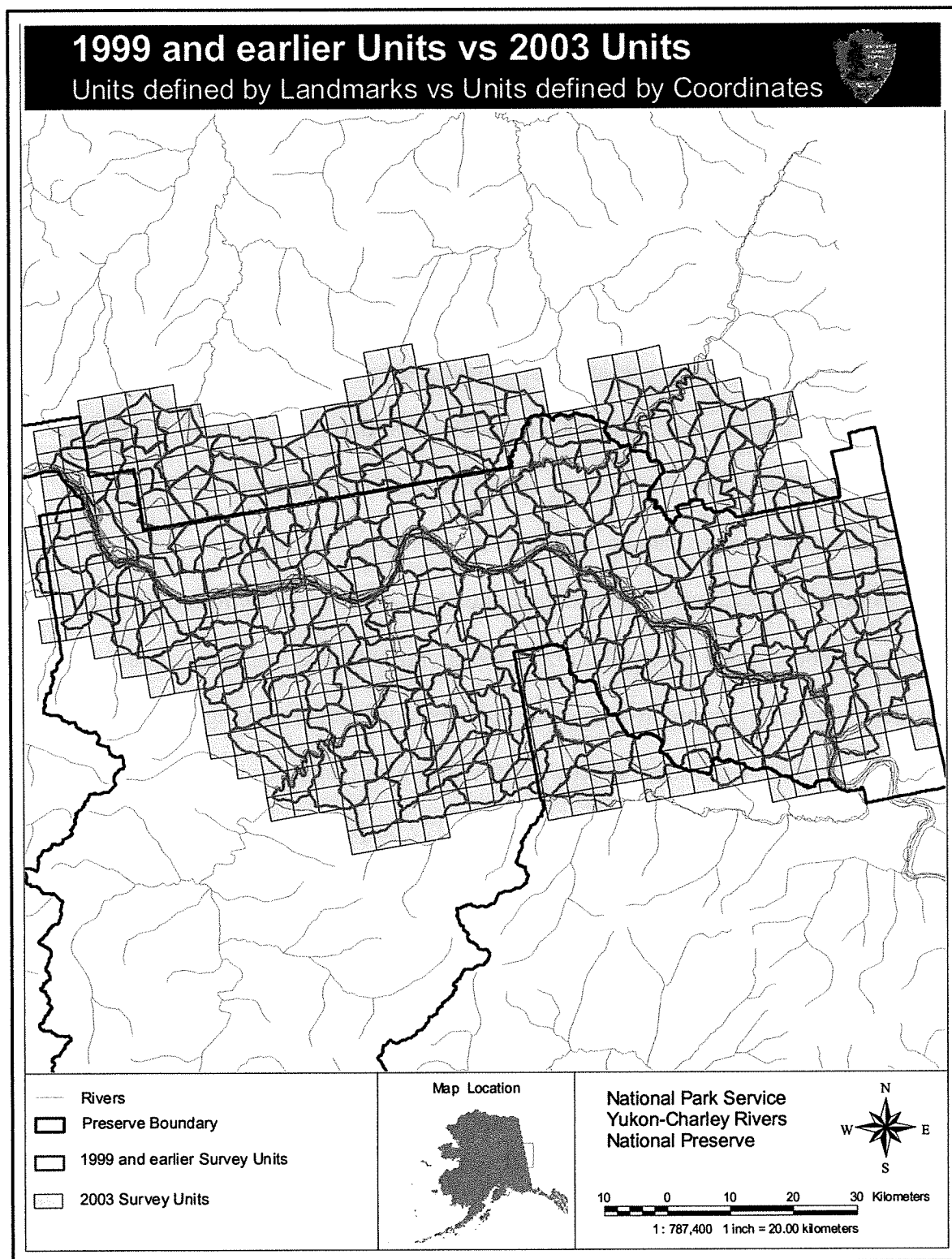


Figure 3. Survey units from 1987, 1997 and 1999 surveys (based on Gasaway et al 1986) compared to the units for this 2003 survey (as modified by Ver Hoef 2001) in Yukon-Charley Rivers National Preserve, Alaska.

RESULTS AND DISCUSSION

Weather and Snow conditions

The weather conditions for flying the survey were good to excellent. Survey flights were stopped for a total of 1.5 days, 1 day of heavy snowfall, and half a day due to cold temperatures at survey altitude (-38° F). There were also occasions when wind prevented surveying in isolated areas but this did not significantly affect the survey. Snow conditions were good throughout the survey area with 8 to 12 inches (20 to 30 cm) of fresh snow at the start of the survey and an additional 11 inches of snow falling (28 cm) during the survey.

Standard Survey

One hundred and six of 566 survey units were surveyed covering 19% of the survey area (Table 1, Figure 2). A total of 65.02 hours (3,901 minutes) of flight time was spent searching for moose for an average of 36.8 minutes per survey unit. Search intensity averaged 6.6 minutes per mi² (2.6 minutes/km²). A total of 159 moose were observed (87 cows, 17 calves [1set of twins], 55 bulls [6 spike/fork (yearling bulls)]) (Table 1).

Population Estimate

Extrapolating observed moose numbers and composition to the entire survey area via the Geo-spatial statistics in SMOOSE generates an overall estimated density of 0.22 moose/mi² (0.085 moose/km²) and an estimate of 696 moose in the 3,157 mi² (8,177 km²) study area (+/- 166 moose (530 – 862) or +/-23.86% @ 90% CI); (Table 2). The composition of the estimated 696 moose was: 375 cows, 94 calves, 227 bulls (of which 24 were spike/fork/yearling bulls).

Table 1. November 2003 moose survey results, Yukon-Charley Rivers National Preserve, Alaska.

Unit	SE Corner Coordinates	Date	Stratum	Area Mi ²	Bulls			Cows			Lone Calf	Unk	Total Moose	Search Time	Effort Min/Mi ²
					Yrl	Med	Lrg	0calf	1calf	2calf					
10	6536-14330	11/19/03	High	5.512	0	0	0	1	1	0	0	0	3	31	5.62
15	6536-14235	11/16/03	High	5.512	0	0	0	0	1	0	0	0	2	35	6.35
16	6536-14230	11/16/03	High	5.512	0	0	4	0	0	0	0	0	4	35	6.35
22	6534-14335	11/19/03	High	5.519	0	0	0	0	0	0	0	0	0	31	5.62
27	6534-14310	11/20/03	Low	5.519	0	0	0	0	0	0	0	0	0	34	6.16
30	6534-14250	11/18/03	High	5.519	0	0	0	0	0	0	0	0	0	11	1.99
36	6534-14220	11/18/03	High	5.519	0	0	1	1	0	0	0	0	2	31	5.62
37	6534-14215	11/18/03	High	5.519	0	0	0	0	0	0	0	0	0	31	5.62
39	6534-14205	11/18/03	Low	5.519	0	0	0	0	0	0	0	0	0	30	5.44
41	6534-14145	11/20/03	Low	5.519	0	0	3	2	0	1	0	0	8	41	7.43
45	6532-14335	11/19/03	Low	5.526	0	0	0	0	0	0	0	0	0	33	5.97
49	6532-14315	11/20/03	High	5.526	0	0	0	0	0	0	0	0	0	30	5.43
57	6532-14235	11/16/03	High	5.526	0	0	0	2	1	0	0	0	4	45	8.14
58	6532-14230	11/16/03	High	5.526	0	0	0	1	0	0	0	0	1	45	8.14
60	6532-14220	11/18/03	High	5.526	0	0	0	0	0	0	0	0	0	35	6.33
61	6532-14215	11/16/03	High	5.526	0	0	0	0	0	0	0	0	0	40	7.24
67	6532-14135	11/20/03	Low	5.526	0	0	0	0	0	0	0	0	0	35	6.33
80	6530-14250	11/18/03	High	5.533	0	0	1	1	1	0	0	0	4	45	8.13
85	6530-14225	11/16/03	High	5.533	0	0	0	0	0	0	0	0	0	35	6.33
86	6530-14220	11/16/03	High	5.533	0	0	0	0	0	0	0	0	0	35	6.33
87	6530-14215	11/16/03	High	5.533	0	0	0	0	0	0	0	0	0	35	6.33
93	6530-14145	11/19/03	High	5.533	0	0	0	0	0	0	0	0	0	33	5.96
105	6528-14315	11/19/03	High	5.540	0	0	0	1	0	0	0	0	1	31	5.60
119	6528-14205	11/18/03	Low	5.540	0	0	0	0	0	0	0	0	0	40	7.22
122	6528-14150	11/18/03	High	5.540	0	0	0	0	0	0	0	0	0	46	8.30
132	6526-14340	11/19/03	Low	5.547	0	0	0	0	0	0	0	0	0	35	6.31
136	6526-14320	11/19/03	High	5.547	0	0	0	0	0	0	0	0	0	33	5.95
149	6526-14215	11/18/03	Low	5.547	0	0	0	0	0	0	0	0	0	30	5.41
150	6526-14210	11/18/03	High	5.547	0	0	0	0	0	0	0	0	0	30	5.41
151	6526-14205	11/18/03	High	5.547	0	0	0	0	0	0	0	0	0	30	5.41
152	6526-14200	11/18/03	Low	5.547	0	0	0	0	0	0	0	0	0	30	5.41
156	6526-14140	11/20/03	High	5.547	0	0	0	0	0	0	0	0	0	26	4.69
164	6524-14340	11/19/03	Low	5.554	0	0	0	1	0	0	0	0	1	31	5.58
173	6524-14255	11/21/03	Low	5.554	0	0	0	0	0	0	0	0	0	39	7.02
182	6524-14210	11/18/03	High	5.554	0	0	0	0	0	0	0	0	0	45	8.10
186	6524-14150	11/20/03	Low	5.554	0	0	0	0	1	0	0	0	2	40	7.20
196	6522-14330	11/20/03	Low	5.561	0	0	0	0	0	0	0	0	0	33	5.93
209	6522-14225	11/21/03	Low	5.561	0	0	0	0	0	0	0	0	0	40	7.19
212	6522-14210	11/18/03	Low	5.561	0	2	0	0	1	0	0	0	4	40	7.19
215	6522-14155	11/20/03	Low	5.561	0	0	0	0	0	0	0	0	0	39	7.01
223	6522-14115	11/18/03	Low	5.561	0	0	0	0	0	0	0	0	0	34	6.11
227	6520-14335	11/20/03	Low	5.568	0	0	0	0	0	0	0	0	0	33	5.93
233	6520-14305	11/21/03	Low	5.568	0	0	0	0	0	0	0	0	0	40	7.18
243	6520-14215	11/18/03	Low	5.568	0	0	0	0	0	0	0	0	0	40	7.18
253	6520-14125	11/18/03	High	5.568	0	0	0	1	0	0	0	0	1	49	8.80
259	6518-14330	11/20/03	High	5.575	1	1	1	3	1	0	0	0	8	40	7.18
272	6518-14225	11/21/03	Low	5.575	0	0	0	0	0	0	0	0	0	39	7.00
283	6518-14130	11/18/03	High	5.575	1	2	2	5	0	0	0	0	10	50	8.97
284	6518-14125	11/18/00	High	5.575	0	2	0	2	0	0	0	0	4	48	8.61
301	6516-14240	11/15/03	High	5.582	0	0	0	0	0	0	0	0	0	25	4.48
306	6516-14215	11/20/03	Low	5.582	0	0	0	0	1	0	0	0	2	40	7.17
308	6516-14205	11/20/03	Low	5.582	0	0	0	0	0	0	0	0	0	62	11.11
309	6516-14200	11/20/03	Low	5.582	0	0	0	0	0	0	0	0	0	62	11.11
315	6516-14130	11/19/03	High	5.582	0	0	0	0	0	0	0	0	0	62	11.11
317	6516-14120	11/19/03	High	5.582	0	0	0	1	0	0	0	0	1	40	7.17
324	6514-14320	11/18/03	Low	5.589	0	0	0	0	0	0	0	0	0	37	6.62
329	6514-14255	11/17/03	Low	5.589	0	0	0	0	0	0	0	0	0	17	3.04

Table 1 continued.

Unit	SE Corner	Date	Stratum	Area Mi ²	Bulls			Cows			Lone		Total Moose	Search Time	Effort Min/Mi ²
					Yrl	Med	Lrg	0calf	1calf	2calf	Calf	Unk			
332	6514-14240	11/17/03	Low	5.589	1	0	0	3	0	0	0	0	4	41	7.34
337	6514-14215	11/15/03	High	5.589	0	0	0	0	0	0	0	0	0	29	5.19
338	6514-14210	11/15/03	High	5.589	0	0	0	0	0	0	0	0	0	18	3.22
348	6514-14120	11/20/03	High	5.589	0	0	0	0	0	0	0	0	0	68	12.17
359	6512-14250	11/17/03	Low	5.596	0	0	0	1	0	0	0	0	1	25	4.47
363	6512-14230	11/15/03	High	5.596	0	0	0	1	0	0	0	0	1	20	3.57
364	6512-14225	11/15/03	High	5.596	0	0	0	0	0	0	0	0	0	20	3.57
365	6512-14220	11/15/03	High	5.596	0	0	0	0	0	0	0	0	0	20	3.57
366	6512-14215	11/15/03	High	5.596	0	0	0	0	0	0	0	0	0	20	3.57
377	6512-14120	11/20/03	High	5.596	0	0	0	0	0	0	0	0	0	75	13.40
381	6512-14100	11/20/03	Low	5.596	0	0	0	0	0	0	0	0	0	83	14.83
384	6510-14310	11/17/03	Low	5.603	0	0	0	0	0	0	0	0	0	20	3.57
392	6510-14230	11/15/03	High	5.603	1	0	0	1	1	0	0	0	4	27	4.82
393	6510-14225	11/15/03	High	5.603	0	0	0	3	1	0	0	0	5	31	5.53
396	6510-14210	11/18/03	High	5.603	0	1	2	2	0	0	0	0	5	31	5.53
397	6510-14205	11/18/03	High	5.603	0	0	2	5	0	0	0	0	7	31	5.53
398	6510-14200	11/18/03	High	5.603	0	0	1	3	0	0	0	0	4	31	5.53
407	6510-14115	11/19/03	High	5.603	0	0	0	2	0	0	0	0	2	76	13.56
417	6508-14250	11/17/03	Low	5.610	0	0	0	0	0	0	0	0	0	18	3.21
418	6508-14245	11/17/03	Low	5.610	0	0	0	0	0	0	0	0	0	18	3.21
421	6508-14230	11/15/03	High	5.610	0	0	1	1	1	0	0	0	4	27	4.81
422	6508-14225	11/18/03	High	5.610	0	0	3	0	0	0	0	0	3	48	8.20
424	6508-14215	11/18/03	High	5.610	0	0	0	1	0	0	0	0	1	51	9.09
426	6508-14205	11/18/03	High	5.610	0	0	0	0	0	0	0	0	0	46	8.20
437	6508-14110	11/19/03	Low	5.610	0	0	0	0	0	0	0	0	0	66	11.76
449	6506-14230	11/15/03	High	5.617	0	0	0	0	0	0	0	0	0	27	4.81
451	6506-14220	11/18/03	High	5.617	0	0	0	2	0	0	0	0	2	47	8.37
466	6506-14105	11/20/03	Low	5.617	0	1	0	0	1	0	0	0	3	39	6.94
474	6504-14240	11/17/03	Low	5.624	0	0	0	0	0	0	0	0	0	17	3.02
475	6504-14235	11/17/03	Low	5.624	0	0	0	0	0	0	0	0	0	17	3.02
489	6504-14125	11/21/03	Low	5.624	0	0	0	0	0	0	0	0	0	30	5.33
490	6504-14120	11/21/03	Low	5.624	0	0	0	0	0	0	0	0	0	30	5.33
498	6502-14255	11/21/03	High	5.631	0	0	0	0	0	0	0	0	0	50	8.88
500	6502-14245	11/17/03	High	5.631	0	0	0	0	0	0	0	0	0	17	3.02
503	6502-14230	11/17/03	Low	5.631	0	0	0	0	0	0	0	0	0	24	4.26
519	6502-14110	11/21/03	Low	5.631	0	0	0	0	1	0	0	0	2	34	6.04
522	6500-14255	11/21/03	High	5.638	0	3	1	4	0	0	0	0	8	34	6.03
525	6500-14240	11/17/03	High	5.638	0	0	0	0	0	0	0	0	0	24	4.26
526	6500-14235	11/17/03	High	5.638	0	0	0	0	0	0	0	0	0	24	4.26
534	6500-14155	11/19/03	High	5.638	0	0	0	0	0	0	0	0	0	45	7.98
535	6500-14150	11/19/03	High	5.638	1	1	1	9	1	0	0	0	14	45	7.98
536	6500-14145	11/19/03	High	5.638	0	1	2	6	0	0	0	0	9	45	7.98
539	6500-14130	11/17/03	High	5.638	1	3	5	1	0	0	0	0	10	54	9.58
540	6500-14125	11/17/03	Low	5.638	0	0	0	0	0	0	0	0	0	49	8.69
556	6458-14140	11/19/03	High	5.645	0	1	1	1	1	0	0	0	5	37	6.55
559	6458-14125	11/17/03	Low	5.645	0	0	0	2	0	0	0	0	2	59	10.45
561	6458-14115	11/21/03	Low	5.645	0	0	0	1	0	0	0	0	1	41	7.26
564	6456-14130	11/17/03	Low	5.652	0	0	0	0	0	0	0	0	0	36	6.37
565	6456-14125	11/17/03	Low	5.652	0	0	0	0	0	0	0	0	0	26	4.60
Total					6	18	31	71	15	1	0	0	159	3875	694.48
Average													1.49	36.86	6.60

Table 2. November 2003, moose survey population estimate, Yukon-Charley Rivers National Preserve, Alaska. Results from the Geo-Spatial Estimator (Ver Hoef 2001).

STRATUM	LOW	HIGH	TOTAL
Total no. of survey units	378	188	566
Total area (mi ²)	2108.1	1049.1	3157.2
No. of units surveyed	45	61	106
Area surveyed (mi ²)	251.28	340.18	591.46
No. of moose seen	30	129	159
Density (moose/mi ²)			0.22
Estimate Total			696
Estimate Standard Error			101.01

80% Confidence Interval = (566, 826) = +/- 130 = +/- 18.68%
 90% Confidence Interval = (530, 862) = +/- 166 = +/- 23.85%
 95% Confidence Interval = (498, 894) = +/- 198 = +/- 28.45%

Sex and Age Composition

The sex and age composition of the 159 observed moose were as follows: 87 cows, 55 bulls, and 17 calves. Composition of the observed bulls included 6 yearling bulls (small spiked or forked antlers), 18 medium bulls, and 31 large bulls. Only 1 large single-antlered bull was seen, therefore antler shed did not appear to be a problem. Bulls begin to loose there antlers in late November, if surveys are conducted after this time sex ratios become increasingly inaccurate and are impossible in a spring (March) survey because bulls cannot be identified from cows consistently from aircraft.

The estimated sex and age ratios of the population were 25 calves:100 cows, 6.5 spike/fork (yearling bulls):100 cows, and 61 bulls:100 cows, twinning rate was 1.15 twins:100 cows. During this November 2003 survey, only one set of twins was seen, in 1999 six sets of twins were seen, in 1997 three sets of twins were seen, and in 1994 a single set of twins was seen.

The total number of yearlings is estimated by doubling the number of yearling bulls, by assuming a 50:50 sex ratio. This would make the ratio 13 yearlings:100 cows. However, the yearling component of the population is likely under-represented because we only classified those bulls with spike or forked antlers as yearlings. Studies conducted by ADF&G indicate that yearling bulls can grow larger palmated antlers up to 30 inches (76 cm), and spike/fork bulls may represent only 40%-60% of the yearling cohort in a given year assuming adequate nutrition (Gasaway et al. 1983, Gasaway et al. 1992). Therefore, if we assume that spike/fork bulls represent 60% of the yearling cohort in YUCH, an additional 40% would increase the total number of yearling bulls to 33 and the total number of yearlings to 66. The ratios would increase to 8.8 yearling bulls:100 cows, or 17.6 total yearlings:100 cows.

Comparisons and Trends

Several moose surveys have been conducted in the past in YUCH (Table 3). However, a variety of study objectives and budget constraints resulted in differing sampling techniques and/or low sample sizes. Comparisons of the earlier surveys (1987 and 1994) with the last three (1997, 1999, 2003) are difficult and perhaps inappropriate, because comparing these data may result in misleading or erroneous conclusions. The aerial moose surveys conducted in November 1997, 1999 and 2003 covered the same area, using directly comparable methods. As with this current survey, the 1994, 1997 and 1999 surveys used techniques based on Gasaway et al.(1986). This survey also used techniques based on Gasaway et al. (1986) but as modified by Ver Hoef (2001).

Table 3. November moose survey data from past years for Yukon-Charley Rivers National Preserve, Alaska. Population estimates for 1987 and 1994 data are not directly comparable to 1997, 1999 and 2003. Composition ratios are probably comparable.

Year	Bull:Cow ratio	Calf:Cow ratio	Yrlbull:Cow ratio ¹	Density moose/mi ²	Population estimate
1987 ²	121	10	14	0.62	1116 (no CI)
1994 ²	84	21	7	0.31	735 (+/-166)
1997	60	28	8	0.27	737 (+/-148)
1999	51	36	5	0.36	979 (+/- 188)
2003	61	25	6	0.22	696 (+/- 166)

¹ spike fork bulls only, not corrected

² not directly comparable with later surveys

The primary differences between the 1994 and 1997 surveys were search intensity and boundaries of the survey area. The 1994 survey was conducted at a lower search intensity (about 1 minute/mi²; Dale et al. (1994). Moose density in the 1200 mi² overlap area was estimated at 0.34 moose/mi² during 1994, 0.23 moose/mi² during 1997, and 0.23 moose/mi² for the 1999 survey (Burch 1999). No significant trend can be measured in the moose population from 1994 to 2003 as illustrated by overlapping confidence intervals (Table 3, Figure 4). Variation in moose densities between years could be the result of many variables including immigration and emigration, snow depth, changes in habitat and forage quantity and quality (succession of preferred browse species), in addition to predation. These data will become more valuable over time when combined with future years of comparable data collected within the framework of a long-term monitoring program. This will allow identification of trends in YUCH moose densities, and to help begin to determine the primary limiting factors of YUCH's moose population.

Population Estimates and Bull: Cow Ratio for YUCH's Moose Population

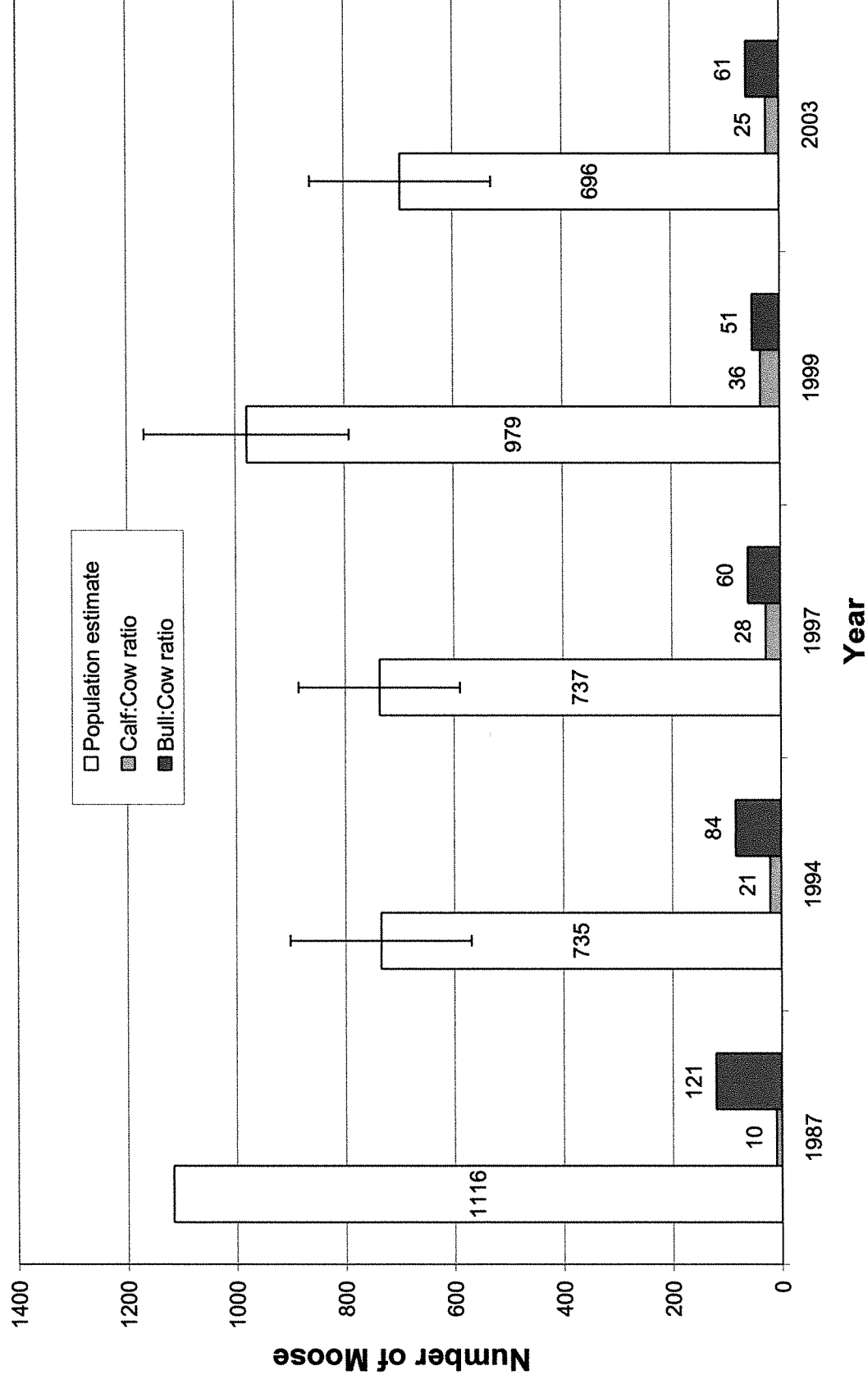


Figure 4. Trends in moose population size, calf:cow ratios and bull:cow ratios 1987 – 2003. Yukon-Charley Rivers National Preserve, Alaska.

Moose densities in YUCH (at 0.22 moose/mi²) appear to be among the lowest reported in the region, and age and sex ratios of the moose population in YUCH are typical of other low-density populations in interior Alaska (Gasaway et al. 1992). In the rest of GMU 20E (of which most of YUCH is a part) the overall moose density in 1995 was 0.54 with 22 calves and 73 bulls per 100 cows (Gardner 1996). In Denali National Park (a predominately un hunted population of moose) Meier et al. (1991) report an overall density of 0.58 moose per square mile and 23 calves, and 81 bulls per 100 cows. In GMUs 25A, 25B, 25D (down the Yukon River from YUCH) moose densities are about 0.6 moose/mi² with 30 calves and 50 bulls per 100 cows (Stephenson 1996). A survey conducted in Yukon Flats National Wildlife Refuge in late October of 1999 reported a density of 0.38 moose/mi² and 31 calves and 31 bulls per 100 cows (Bertram and Vivion 1999) and in November of 2001 Bertram (2004) reported 0.29 moose/mi² with 52 bulls and 27 calves per 100 cows. This is in contrast with GMU 20A south of Fairbanks where moose densities have been much higher at 2.7 moose/mi² and 52 calves and 35 bulls per 100 cows (Dale 1996).

The Geo-Spatial method assumes 100% sightability of moose during a survey (Ver Hoef 2001; Ver Hoef pers. comm.). The reality is likely something less. Previous stratified random surveys missed between 10% and 20% of the moose but survey rate was closer to 4 - 5 minutes per square mile covering individual sample units that were up to 3 times larger than the survey units used by the Spatial Estimator of approximately 5.5mi² and flown at a rate of 6 - 7 minutes/mi². Tests run by Gasaway et al. (1986) indicate that on average, for early winter surveys, 98% of the moose are seen when surveying at a rate of 12 minutes/mi², and approximately 90% – 95% are seen when flying at a rate of 7 minutes/mi² in interior Alaska. This survey averaged 6.6 minutes/mi² of search time. The addition of a sightability correction factor = 1.10 would produce an estimate of 765 moose or a density of 0.24 moose/mi², so the addition of a sightability correction factor would not substantially change the overall estimate for this area.

Harvest

Moose harvest and hunter success from 1983 to 2002 was summarized from ADF&G harvest data (Table 4 and Figure 4). The area covered includes all Uniform Coding Units (UCUs) within the 3 Game Management Units (GMU) and subunits that are completely or partially within YUCH (Figure 5). Moose harvest in YUCH averaged ($\pm$ SE) 26 bulls/yr over the 20 year period (range 12-41, SE=2.08) and there is a significant increase in moose harvest overall ($r^2=0.434$, $F=13.83$, $p=0.002$, $\alpha=0.05$). The average ($\pm$ SE) moose harvest for the first 10 years ($A_v=19.8$, SE=2.39) is significantly different from the average ($\pm$ SE) of the last 10 years ($A_v=32.4$, SE=1.94; $t=-4.43$, $p<0.0017$, $\alpha=0.05$). These tests indicate a significant increase in the number of moose harvested since 1983. During 1983-2002, an average of 87 hunters (range 41-145, SE=6.59) hunted moose in the preserve each year, spending an average of 8 days per hunt. Comparing the average number of hunters from the first 10 years (65) to the last 10 years (108) indicates a significant increase in the number of people hunting in the preserve ($t=-6.99$, $p<0.001$, $\alpha=0.05$). Furthermore, there is also a significant trend in the increase in the number of hunters over the 20 year period ($r^2=0.77$, $F=58.58$, $p<0.001$, $\alpha=0.05$). Reported hunter success has averaged 31.4% (range 12-46%) during this 20 year period. Average hunter success during the first 10 years (31.8) is not significantly different from the last 10 years (30.9; $t=0.219$, $p=0.832$, $\alpha=0.05$) indicating an increase in the number of hunters, but the success of hunters has remained about the same. Moose hunting in the preserve occurs primarily along the main rivers such as the Yukon, Kandik, Nation, and Charley Rivers. Hunters also use airstrips and remote landing areas within YUCH and harvest some moose considerable distances from the main rivers.

Table 4. Reported moose harvest, number of hunters, hunter effort and success in Yukon-Charley Rivers National Preserve, Alaska, 1983 to 2002.

Year	Moose Harvested	Number of Hunters	Percent Success	Hunter Effort Days/Moose	Hunter Days
1983	21	59	36	28	597
1984	19	46	41	17	326
1985	19	41	46	21	399
1986	13	48	27	20	260
1987	14	57	25	30	413
1988	17	66	26	27	464
1989	17	61	28	28	476
1990	35	81	43	15	538
1991	31	90	34	24	747
1992	12	100	12	62	739
1993	36	93	39	20	719
1994	32	126	25	29	926
1995	33	99	33	24	797
1996	24	94	26	33	793
1997	24	100	24	35	851
1998	37	80	46	22	828
1999	41	116	35	24	987
2000	38	102	37	23	873
2001	25	145	17	45	1117
2002	34	129	26	28	952
Total	522	1733	628	556	13802
Mean	26.1	86.7	31.4	27.8	690.1
first 10yr mean	19.8	64.9	31.8	27.2	495.9
last 10yr mean	32.4	108.4	30.9	28.4	884.3
last 5yr mean	35.0	114.4	32.5	28.4	951.4

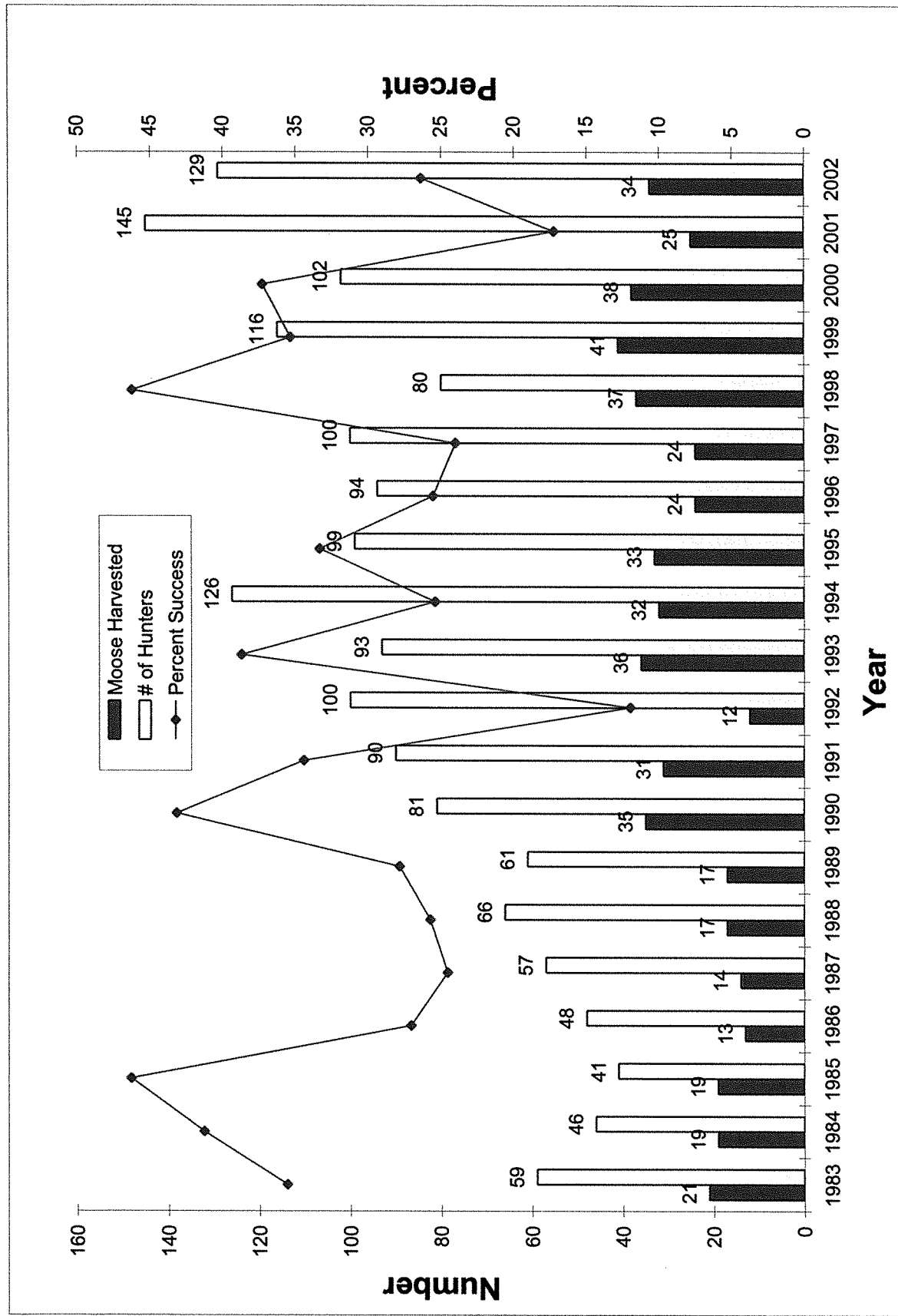


Figure 4. Reported moose harvest, number of hunters, and hunter success in Yukon-Charley Rivers National Preserve, Alaska, 1983-1999 (data gathered from ADF&G harvest reports).

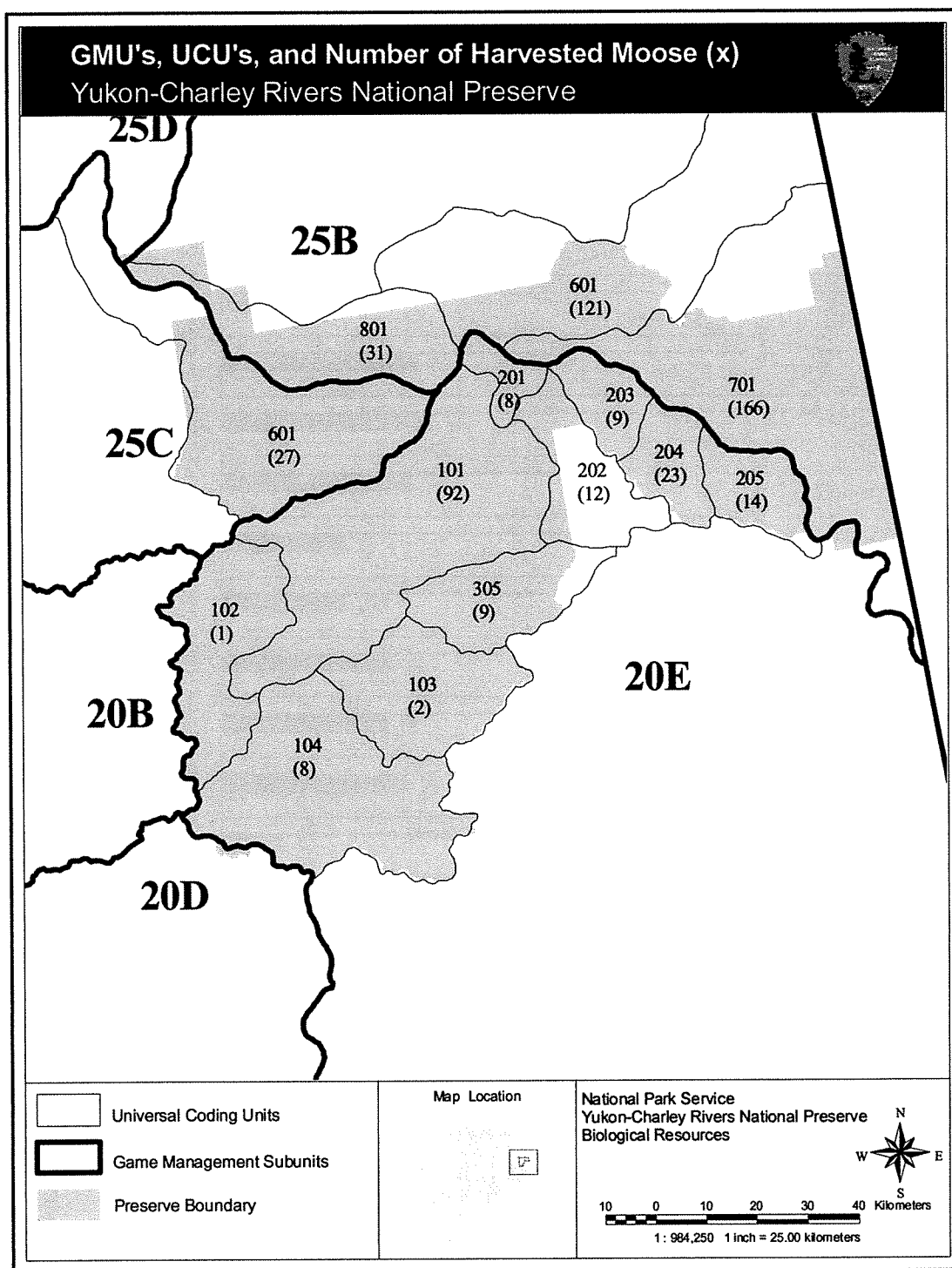


Figure 5. Game management subunits and uniform coding units (UCUs) comprising Yukon-Charley Rivers National Preserve, Alaska. Numbers in parentheses are number of moose reported harvested from 1983-2002 for each UCU.

Natural Mortality

We know very little about the natural mortality of moose in YUCH. Nearby studies over past years indicate that bear (both black and brown species) predation on newborn calves can be significant in the spring and wolf predation on calves and adults is significant. From 1981-1988 ADF&G intensively studied the moose population in Fortymile drainage south of YUCH where, in a study of 33 radiocollared newborn calves, 82% died within 11 months (52% by grizzly bears, 15% by wolves, 3% by black bears, and 12% drowned) (Gasaway et al. 1992). In the same study they found survival rates of adult moose to range from 78% to 93%. In 1998 and 1999 in Yukon Flats National Wildlife Refuge, data from a moose calf mortality study found 32 of 80 (40%) collared calves were killed by bears (17 by black bears, 15 by brown bears) and only a single calf known to be killed by a wolf, there were however 26 mortalities of unknown cause (Bertram and Vivion 2002). A moose study in Denali National Park and Preserve calculated survival rates for adult cows at 86%, 88%, and 94% for years 2000, 2001, 2002 respectively (Layne Adams, USGS/BRD personal communication).

Wolf predation is a common cause of death of adult moose as well as calves in YUCH (Burch 2002). During routine radiotracking flights from an on-going wolf study in YUCH, there has been no significant increase in locations of wolves on moose kills from 1993 – 2002 ($r^2 = 0.007$, $F=0.066$ $p=0.80$, $\alpha=0.05$) (Table 5) (Burch 2002).

Table 5. Number of moose kills observed with radiocollared wolf packs.

Year	Total Locations	Moose kills	%Moose kills
1993	189	5	2.6
1994	286	21	7.3
1995	268	17	6.3
1996	113	11	9.7
1997	353	22	6.2
1998	435	8	1.8
1999	346	7	2.0
2000	300	10	3.3
2001	303	16	5.3
2002	189	11	5.8
2003*	67	3	4.5
2004*	30	2	6.6

* very few radiotelemetry flights due to budget constraints.

Distribution of Moose

The location of moose throughout the survey area in YUCH appear to be concentrated in the hills within the greater Yukon Valley. This is illustrated by the distribution of moose groups from the 1997, 1999, and 2003 surveys, and the distribution of wolf-killed moose from 1993-2001 throughout YUCH (Figure 6). From the survey locations of moose groups in November it appears that moose congregate in the hills on either side of the Yukon. Assuming that most moose are shot near the Yukon River or its major tributaries in September, this could indicate some evidence of moose migrating into the hills in the fall, or that one portion of the population is absorbing the majority of the harvest. It is possible some moose may move farther, and the population in the Yukon valley during the September hunt is higher than indicated by moose surveys in November. The scatter of wolf-

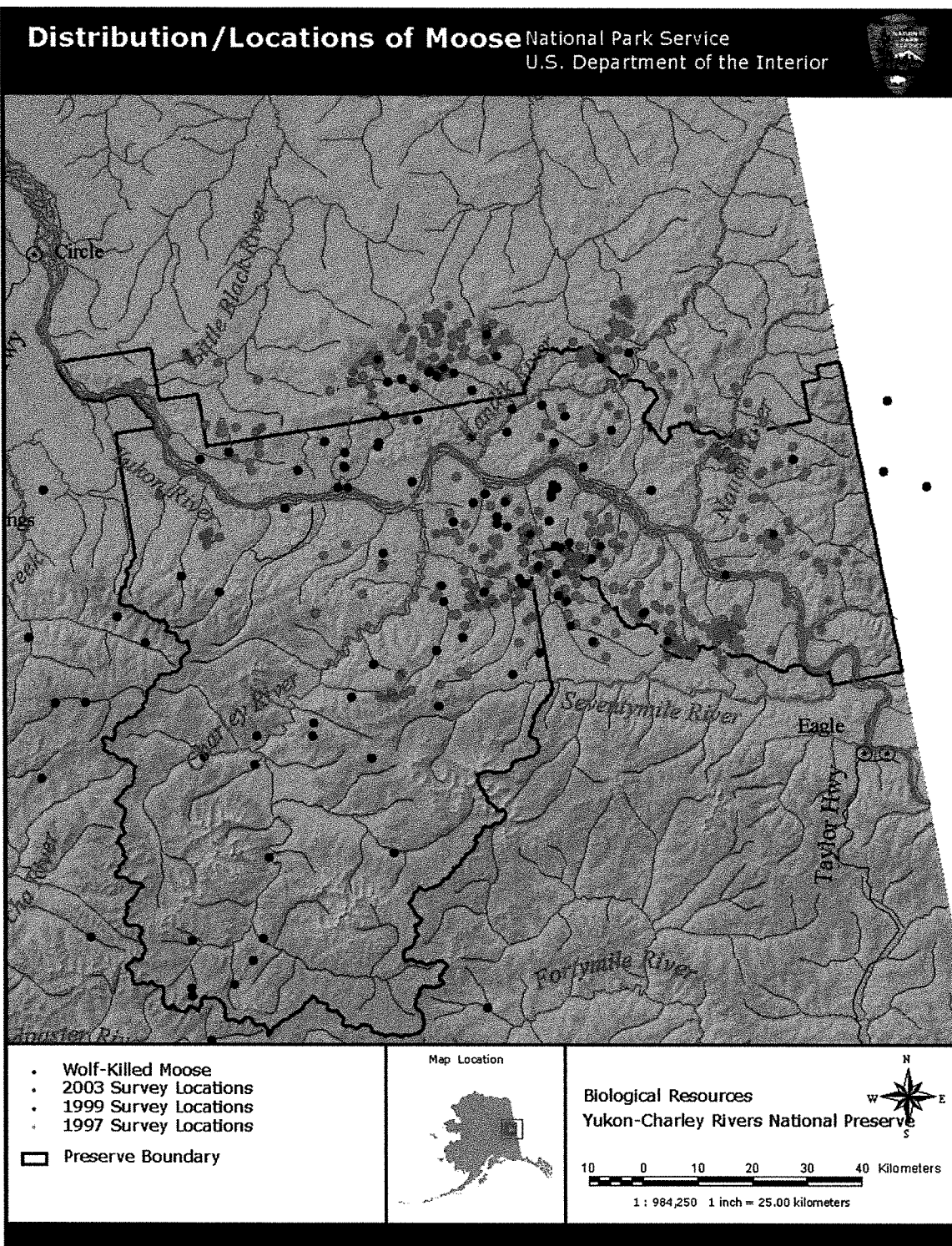


Figure 6. Distribution of moose group locations from 1997, 1999, and 2003 surveys and the distribution of wolf-killed moose (black dots) from 1993-2001, in Yukon-Charley Rivers National Preserve, Alaska.

killed moose throughout the preserve and beyond, gives some idea of moose distribution outside the surveyed areas (Figure 6).

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

The overall density of 0.22 moose/mi² is among the lowest reported in interior Alaska (Gasaway et al. 1992). The population estimates and sex and age composition of the YUCH moose population appears consistent with that of a low density stable population.

While the number of hunters has increased since the early 1980s, hunter success rates have remained comparable to the 20 year average. A proposal to lengthen the federal subsistence hunting season on bulls and to include any bull, was adopted in 1998, changing the season dates within YUCH. Since 1998, federal subsistence regulations now include August 29-31 making a subsistence season that extends from August 20 to September 30 for any bull (a change from one bull with spike-fork antlers from August 20-August 28, and no season from August 29-August 31). A proposed March hunting season was not adopted but could be proposed again in the future. The YUCH moose population could be at the maximum sustainable harvest levels right now. Extending hunting seasons to include a March season and the subsequent additional harvest could adversely affect YUCH's moose population.

Another factor complicating management of the moose population in YUCH is the lack of knowledge of moose movements in and adjacent to YUCH. Studies of other moose populations in interior Alaska have documented significant moose movements (Hobgood and Durtsche 1990, Gasaway 1992, Dale and Boertje unpublished data). Some of these movements are migratory in nature and occur seasonally (spring and fall). Anecdotal information suggests that snow and other factors may influence the timing and magnitude of movements. These movements may

affect the results of moose surveys, and the November survey results may not be representative of the moose population during the August/September moose hunt. Information on the timing and extent of moose movements within and adjacent to YUCH is critical for managers to develop, and implement an appropriate monitoring protocol that will contribute to science-based management decisions.

Available moose population information for YUCH is adequate for current decisions, but need to continue for future management decision making. A long-term monitoring program with consistent and comparable sampling techniques should be implemented to track the status of the YUCH moose population. A Geo Spatial population survey modeled after Gasaway et al. (1986) and modified by Ver Hoef (2001) should be conducted every 3 or 4 years, and would cost about \$30,000 per survey. The next survey should occur in fall 2006 or 2007. This monitoring level would provide managers with statistically reliable population estimates and a consistent means to estimate sex and age composition. In addition, a study of moose movements in YUCH would provide valuable information to assist in determining an appropriate population monitoring protocol and allow managers to make informed decisions regarding moose management to maintain healthy populations for future generations.

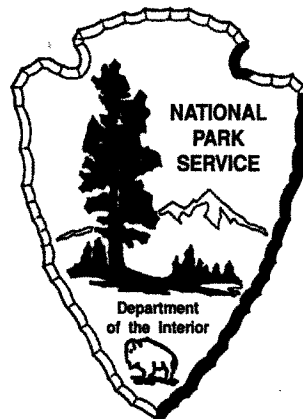
ACKNOWLEDGMENTS

This survey was funded by U.S. National Park Service, Yukon-Charley Rivers National Preserve, Alaska. Aircraft support provided during the survey by D. Glaser, S. Hamilton, J. Martin, and D. Miller was much appreciated. M. Cook, N. Guldager, A. Larsen and J. Lawler assisted as observers in aircraft. P. Sanders and L. Flynn provided communications support in Eagle. J. Lawler made a number of valuable suggestions on earlier drafts of this report.

LITERATURE CITED

- Alaska Department of Fish and Game. 1995. Fortymile Caribou Herd management plan. 21pp.
- Bertram, M. and M. Vivion. 2002. Moose mortality in Eastern Interior Alaska. *Journal of Wildlife Management* 66(3):747-756.
- Boertje, R. D. 1985. Letter to Steve Ulvi, National Park Service. April 9, 1985. Alaska Department of Fish and Game. 2pp.
- Burch, J. W. and N. J. Demma. 1997. 1997 Aerial moose survey along the Yukon River corridor, Yukon-Charley Rivers National Preserve, Alaska. NPS Technical Report NPS/AR/NRTR-98/33. 23pp.
- Burch, J. W. 1999. 1999 aerial moose survey along the Yukon River corridor, Yukon-Charley Rivers National Preserve, Alaska. NPS Technical Report NPS/AR/NRNT-2002/40. 25pp.
- Burch, J. W. 2002. Ecology and demography of wolves in Yukon-Charley Rivers National Preserve, Alaska. NPS Technical Report NPS/AR/NRTR-2001/41. 72pp.
- Demma, N. J., B. W. Dale, and K. B. Fox. 1995. 1994 Aerial moose survey, Yukon-Charley Rivers National Preserve, Alaska. NPS Tech Report NPS/ARRNR/NRTR-95/26. 14pp.
- Dale, B. W. 1996. 1996 moose management report (20A). Alaska Department of Fish and Game report, Fairbanks, Alaska. 15 pp.
- Dale, B. W., L. G. Adams, and W. T. Route. 1994. A relatively inexpensive aerial moose survey technique designed as a replacement for trend surveys or for the use in areas with high sightability. NPS Natural Resources Report AR-94. 15 pp.
- Gardner, C. L. 1996. 1996 Moose management report (20E). Alaska Department of Fish and Game report, Fairbanks AK. 14pp.

- Gasaway, W. C., R. D. Boertje, D. V. Grangaard, D. G. Kelleyhouse, R. O. Stephenson, and D. G. Larson. 1992. The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. Wildlife Monograph 120. 59pp.
- Gasaway, W. C., S. D. Dubois, D. J. Reed, and S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biological Papers, University of Alaska. No. 22. 108pp.
- 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 Monograph 84. 50 pp.
- Hobgood, W., and B. M. Durtsche. 1990. Ecology of moose in the White Mountains National Recreation Area, Alaska, 1985-88. BLM-Alaska Open File Report. No. 27. 17pp.
- Knuckles, P. 1991. Moose winter habitat survey, Nation River, Yukon-Charley Rivers National Preserve. NPS research and resource management report series 91-02. 4pp.
- Meier, T. J., J. A. Keay, J. C. VanHorn, J. W. Burch. 1991. 1991 Aerial moose survey, Denali National Park and Preserve. National Park Service Natural Resources Survey and Inventory Report AR-91/06. 19pp.
- National Park Service. 1985. Yukon-Charley Rivers National Preserve general management plan. Preserve files, Fairbanks, Alaska. 147pp.
- National Park Service. 1999. Fire management plan for Yukon-Charley Rivers National Preserve, Alaska. Preserve files, Fairbanks, Alaska. 50pp.
- Nowlin, R. 1988. Summary of Yukon-Charley Rivers Preserve moose survey results conducted by ADF&G and NPS during November 1987. Preserve files, Fairbanks, Alaska. 15pp.
- Reed, D. J. 1989. Moosepop program documentation and instructions. Alaska Department of Fish and Game. 15pp.
- Stephenson, R. O. 1996. 1996 Moose management report (25A,25B, and 25D). Alaska Department of Fish and Game report, Fairbanks, Alaska. 25pp.
- Swanson, D. K. 1999. Ecological units of Yukon-Charley Rivers National Preserve, Alaska. National Park Service report YUCH-99-001, Fairbanks, Alaska. 31pp.
- 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.
- Ver Hoef, J. M. 2002. Sampling and geostatistics for spatial data. Ecoscience 9: 152-161.



As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environment and providing for outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interest of all our people. The department also promotes and encourages stewardship and citizen responsibility for the public lands and promoting citizen participation in their care.

August, 2004