Susitna Hydroelectric Project

PROCEDURES MANUAL

SUBTASK 7.11, WILDLIFE/BIG GAME

Oct 1980

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I. INTRODUCTION

The primary objectives of Phase I big game studies are to determine the probable nature and approximate magnitude of impacts of the proposed Susitna Hydroelectric Project on moose (Alces alces), black bear (Ursus americanus), brown bear (Ursus arctos), wolf (Canis lupus), wolverine (Gulo gulo), caribou (Rangifer tarandus) and Dall sheep (Ovis dalli). It is anticipated that estimates of the magnitude of impacts will be refined during Phase II.

The basic study approach is to delineate "subpopulations" of each species that use areas likely to be altered by the project, determine the seasonal ranges and movement patterns of these subpopulations, determine the degree of dependency of each population on areas likely to be impacted by the project and estimate the approximate number of animals likely to be impacted. The definition of "subpopulation" will vary depending on the species. It ranges from a pack of wolves to the entire Nelchina caribou herd. Generally, studies will focus initially on animals in or near areas likely to be impacted, then be expanded to the remainder of the subpopulation. As a result, the boundaries of the study area will vary among species and may expand as the ranges of subpopulations become more evident. During Phase I, studies will be confined to assessing the impacts of proposed impoundments and facilities in the vicinity of the impoundments. The one exception will be moose for which the possible effects of downstream habitat alteration will be examined. Phase I studies are not intended to address impacts on other species downstream or along transmission corridors.

Specific study objectives for each species vary according to suspected differences in the nature of their use of proposed impoundment areas and in the likely mechanisms of impacts. The specific objectives, by species are:

Moose (upstream)

To identify moose subpopulations using habitats that will be inundated by proposed impoundments.

To determine the seasonal distribution, movement patterns, size and trends of those subpopulations.

To determine the timing and degree of dependency of those subpopulations on habitat to be impacted by the Susitna Hydroelectric Project.

Moose (downstream)

To identify moose subpopulations using habitat that will be altered by changes in stream flow below Devils Canyon.

To determine the seasonal distribution, movement patterns, size and trends of those subpopulations.

To determine the timing and degree of dependency of those subpopulations on habitat to be impacted by altered flow regimes of the Susitna River.

Wolf

To identify wolf packs occupying areas that will be impacted by the Susitna Hydroelectric Project.

To delineate the territories of each pack and identify den sites, rendezvous sites and major feeding areas.

To determine the numbers of wolves and rates of turnover for each pack.

To determine the food habits of each pack.

Wolverine

To determine the distribution and abundance of wolverine in the vicinity of proposed impoundments.

To determine movement patterns and home range size of wolverines.

Bear (black and brown)

To determine the distribution and abundance of black and brown/grizzly bears in the vicinity of proposed impoundment areas.

To determine seasonal ranges, including denning areas, and movement patterns of bears.

To determine seasonal habitat use of black and brown/grizzly bears.

Caribou

To delineate calving areas.

To determine the numbers and sex and age composition of caribou occupying habitats on both sides of proposed impoundments at different seasons.

To determine migration routes and the timing of major movements in the vicinity of proposed impoundments.

Dall Sheep

To determine the distribution and abundance of Dall sheep adjacent to proposed impoundments.

II. TECHNICAL PROCEDURES

A. Animal Tagging

Capture Techniques

The primary animal capture technique for all species will be the use of immobilizing drugs administered with projectile syringes shot from a helicopter. This technique was first used on moose (Nielson and Shaw 1967) and has since beed adapted for use on other species down to the size of wolverine. The basic technique involves location of animals from a fixedwing spotter aircraft (usually a PA 18-150). Once an animal is located a helicopter (Bell 206 or equivalent) is manuvered close to the animal. A gunman seated behind the pilot shoots the animal with a drug filled dart (Palmer Cap-Chur equipment) through a specially modified door. Drugs used, dosages, dart size and other details of the technique vary with the species of animal, terrain and other considerations. Specifics of the techniques are described in more detail in numerous recent ADF&G research reports and publications (e.g. Ballard and Spraker 1979, Davis and Preston 1980, Franzmann et al. 1974, Gasaway et al. 1978, Hebert and McFetridge 1979, Spraker et al. 1980, Stephenson 1978).

Other live trapping techniques may be employed for bears or wolverine if helicopter darting appears to result in data gaps or biases. If this becomes necessary, trapping techniques successfully used in other parts of Alaska will be adapted (Magoun 1978, Modaferri 1978, Schwartz and Franzmann 1980, Wood 1976).

Numbers of animals of each species to be captured will be determined more by practical than by biological or statistical considerations. The number of animals that can be radio-tracked in a day or the number of frequencies that can be monitored on receiving equipment are limiting factors. We will attempt to radio-collar enough individuals in each "subpopulation" to determine the general movement patterns of that subpopulation. The suspected number of subpopulations, size and range of each population, extent of movements, suspected magnitude and nature of impacts of dam construction, and specific study objectives will influence the number of radio collars placed on each species.

Capture Data

The following types of data will be collected from each animal at the time of capture whenever practical.

1. Location
2. Sex
3. Age - When possible a tooth will be extracted and age will be estimated from counts of cementum annuli. Specific age determination techniques are described in a manuel maintained in the ADF&G, Game Laboratory in Anchorage.

4. Morphometric measurements - A variety of body and skull measurements will be made. See data collection forms (Figs. 1-4).
5. Blood samples will be collected and analyzed to indicate relative physiologic status. See Franzmann et al. (1976) and Franzmann and LeResche (1978) for details of technique and interpretation (Figs. 5 and 6).
6. Hair - Hair samples will be collected for mineral level analysis (Franzmann et al. 1976)(Figs. 5 and 6).
7. Reproductive status - Reproductive status will be determined through presence of young, condition of mammae and external genetalia and in the case of moose captured in late winter or spring, rectal palpation (Figs. 1-4).
8. Miscellaneous - A variety of other types of data may be collected when available. Examples are fecal samples, notes on pathological conditions, coloration, details of drug reaction, etc.

Marking Data

All captured animals of suitable size will be fitted with radio collars. All collars will be of standard manufacture. (Those made by Telonics Inc., Mesa, Arizona will be used at least during the first year.) Frequencies will be in the 148.0 to 153.9 MHz range. A variety of radio configurations such as double transmitters, double batteries, mortality sensors etc. will be used depending on the specific use of the transmitter.

All animals captured will be ear tagged and bears will be lip tatooed. In most cases, flagging material or numbered collars will be used in conjunction with radio collars and ear tags to aid in visual recognition.

B. Radio-tracking

Radio-collared animals will be relocated from a fixed-wing aircraft (Cessna 180 or PA 18-150) equipped with two Yagi antennas, one attached to wing struts on each side of the plane. Antenna leads are attached to a right/left switch box coupled to a radio receiver/scanner (Telonics Co., Mesa, Arizona). The radio-tracking techniques will be similar to those described by Mech (1974).

Data recorded at each relocation of a radio-collared animal will vary among the different species. Locations of caribou will be marked on 1:250,000 scale maps. Locations of other species will be marked on either 1:63,360 scale USGS maps or aerial photos of approximately the same scale. Other data describing characteristics of the location, time of the sighting, association with other animals, activity, etc. will be recorded on standardized forms (Figs. 7-15). Habitat types will be classified by Viereck and Dyrness (1980) system.

Figure 1.

MOOSE TAGGING RECORD

Moose No._______________ Location__________________

Sex______ Age______ Date____________________

Collar Color____________ Ear Tag No(s) & Color(s)

Number____________ Radio Frequency ________ LE____________________

Metal Tag No.__________ RE____________________

Year Born_____________ W/Calf____ Operators_________________

Blood: Yes___ No___ Tooth: Yes___ No___ Hair: Yes___ No___

Measurements: T.L.___ H.F.___ H.S.___ Girth___ Head___ Neck___

Excit.___ Cond.___ H.R.___ Temp.___ Amb. Temp._____

Antler Spread______ Antler Base______ Weight______ PG Yes__ No__

Remarks:____

____

Calf Tagged: Yes___ No___ Accession No.________________

DARTS:

No. 1

Time	Hour	Min.	Sec.
Hit	:	:	
Down	:	:	
M50-50	:		
Up	:	:	

Hit Location:____________________

Drug/Dosage:____________________

No. 2

Time	Hour	Min.	Sec.
Hit	:	:	
Down	:	:	
M50-50	:	:	
Up	:	:	

Hit Location:____________________

Drug/Dosage:____________________

Figure 2.

Caribou Tagging Record

Caribou No.________________ Location________________________________

Sex________________________ Age________________________ Date________________

Collar Color______________ Ear Tag No.(s) and Color(s)

Number______________ LE____________________

Metal Tag No.______________ RE____________________

Radio Frequency____________ Radio No.________________________________

Measurements: Total Length______________ Girth____________________

Hind Foot______________ Neck________________________ Head____________________

Operators____________________________ Preg. yes____ no____ unk.____

Blood: yes____ no____ Hair: yes____ no____

Feces: yes____ no____ Accompanied by calf?________________

Excit.____ Cond.____ HR____ Temp.____ Antlers present: yes____ no____

Remarks: ____

DARTS

No. 1

Time	Hour	Min.	Sec.
Hit	:	:	
Down	:	:	
M50-50	:	:	
Up	:	:	

Hit Location:____________________

Drug/Dosage______________________

No. 2

Time	Hour	Min.	Sec.
Hit	:	:	
Down	:	:	
M50-50	:	:	
Up	:	:	

Hit Location:____________________

Drug/Dosage______________________

WOLVERINE/WOLF TAGGING AND NECROPSY RECORD

Figure 3.

ACCESSION NO.__________ Radio # __________

Trapper or Taggers Name __________ Seal No. __________

('ress __________ Sealing Date __________

Ear Tag Numbers: Left ____ Right ____ Measured by __________

Specific location of capture __________

Method of harvest or capture __________ Date of harvest or capture __________

Age ____ Based on: tooth wear ____ leg bone ____ tooth __________

Sex __________ Color phase __________

Animal accompanied by how many other wolves (give color phase) __________

____

SPECIMENS COLLECTED (check):

skull ______ tooth ______ blood ______ hair ______

repro. tract ______ adrenal ______ thyroid ______ liver ______

muscle ______ stomach contents = I.D. ______ weight ______

leg bone(s) ______ femur ______ hind quarter ______

Special notes: __________

____

MEASUREMENTS:

Weight: carcass and hide ______

carcass only ______

hide only ______

Depth of rump fat ______

Depth of flank fat ______

Depth of back fat ______

Depth of sternum fat ______

Facial fat (trace, 1,2,3) ______

Chest height ______

Neck circumference ______

Nose to base of tail ______

Base of tail to last vertebrate ______

Front right hock to nail tip ______

Front right hock to tip of pad ______

Right shoulder to nail tip ______

Rear right hock to nail tip ______

Length of right ear ______

Width of right front paw ______

Raw skull length ______ width ______

Skull length ______ width ______

Length upper canine ______ width u. canine ______

Heart girth ______

MISCELLANEOUS NOTES __________

____

Figure 4.

Black-Brown Bear Tagging Record Data--Susitna Hydro Project

Bear No. ________ Date __________ Sex _________ Est'd. Age __________ Cem. Age __________

Collector ______________________ Recorder ____________________ Recapture ____ New ______

	Temp.	Pulse Rate	Resp. Rate	Convulsion	Tremor	Other
Time						
Time						

Were all darts checked for complete drug injection? Yes _____ No _____

MEASUREMENTS: Measured Wt. ________ T.L. ______ Ht. Sh. _____ H.F. ______ Neck _____

Girth ______________ B. L. ____________ Head: Width ______________ Length ______________

Length of Upper Left Canine ____________________ Lower Left Canine _____________________

PHOTOGRAPHS: Dentition ( ), Collar ( ), Mammae ( ), Whole Bear ( ), Vulva ( )

SPECIMENS COLLECTED: Tooth (Be specific) _______________ Blood: Vol. _______________

Blood Smear: Yes ____ No ____ Vag Smear: Yes ____ No ____ Feces: Yes ____ No _____

Urine: Yes ____ No ____ Milk: (No less than 10 ml prefer 100-200 ml) Vol.__________

PRODUCTIVITY: Female: No. of .5 yr. Olds _______ 1.5 yr.________ 2.5 yr. ___________

Mammae: Length _____ Color _____ Vulva: ______ Male: Testes Descended: Yes __ No __

Other Bears Present (Describe) ____

RECAPTURE DATA: Tattoo: No. _____ Condition ______ Ear Tags (Number, Type, Condition):

Left____ Right ___________________________

Collar (Number, Type, Condition)____

NEW TAG DATA: Left Ear: Large Roto No. ______ Color ______ Small Roto No. ________

Color _______ Right Ear: Large Roto No. ______ Color ______ Small Roto No. ________

Color _______ Collar: Type ______________________ Collar Color Code:_______________

________________________________ Collar Plate Ident.: Figure ____________________

Temporary Markings: ____

Time Departed ___________________________________ Completeness of Recovery__________

Comments: ____

____

Punch Tattoo No. Here

Time Bear First Observed ____________________

Specific Location ____

Grid No. _______ Map Coordinates ____

DRUG DATA: Est'd. Wt. __________ Circle Each Used: 1. Sernalyn 2. Sparine 3. M-99 4. M. 50-50 5. Other

	Dosage	Time Darted	Time Down	Dart Location
1st Hit				
2nd Hit				
3rd Hit				
Total				

Cont. Comments:

RESIGHTINGS:

Figure 5.

SYSTEM NUMBER	SPECIE	IDENTIFICATION	DATE: MONTH	DAY	YEAR	↓	UPDATE CODE: 1 - DELETE, 2 - ADD, 3 - REVISE
1 1							

Ø1 Ø4 Ø6 10 11 13 15 17

CARD	SEX	DRUG	DOSE	DOWN TIME	LOCATION	REPRT	AGE (MONTHS)	TOTAL LENGTH (CM)	HIND FOOT (CM)	SHOULDER HEIGHT (CM)	CHEST GIRTH (CM)	EAR (CM)	TAIL (CM)	NECK (CM)	WEIGHT BODY (KG)	WEIGHT CARCASS (KG)	WEIGHT HIDE (KG)
1																	

18 19 2Ø 21 22 24 28 29 32 35 38 41 44 46 48 5Ø 54 58 6Ø

CARD	GLUC.	CHOL.	TRI GLYCER	LDH	SGOT	SGPT	ALK. PHOS.	PHOS.	CA	IRON	CA/P RATIO	C/BUN RATIO	NA	K
2														

18 19 22 25 28 31 34 37 4Ø 43 46 49 52 55 58 59

CARD	CHLORIDE	CO2	BUN	CREAT	BILI	TP SMAC	ALB. SMAC	URIC ACID	GLOB SMAC	BALANCE	TP (ELEC)	ALB. (ELEC)	GLOB (ELEC)	ALPH 1	ALPH 2	BETA	GAMMA	A/G RATIO
3																		

18 19 22 24 26 28 3Ø 32 34 36 38 4Ø 43 46 49 51 53 55 57 59

CARD	WBC	NEUTROPH	LYMPHOCY	DIFF	HB (GM)	PCV	MCV %	MCHC %	MARROW % FAT	EXCIT	COND	HEART RATE	RESP. RATE	RECT TEMP	CLASS	AMB. TEMP	CLASS	AGE-CT	SEASON AGE CLASS	PARA
4																				

18 19 21 23 25 26 29 31 34 37 4Ø 41 43 46 49 52 53 56 57 58 6Ø

CARD	CA	MG	K	NA	ZN	CU	CD	CO	FE	PB	MN	CR	HG	MO
5														

18 19 23 26 3Ø 34 38 41 43 45 49 52 54 56 59 6Ø

CARD	SE	AL	NI	AS	CESSIUM	RUMP FAT	FLANK FAT	BACK FAT	STERN FAT	LOIN SCAN.	RUMP SCAN.	ANTLER SPREAD	ANTLER BASE	BOONE CROCKET SCORE
6														

18 19 21 23 25 28 32 34 36 38 4Ø 44 48 51 54 57

CARD	SKULL LENGTH (CM)	SKULL WIDTH (CM)	V.L.C LGTH (CM)	L.L.C LGTH (CM)	TEAT WDTH (CM)	AGE WEAR NO.	COLOR NUMBER (PACK)	WRIST TO NAIL	WRIST TO PAD	SHOULDER TO NAIL	SHOULDER TO PAD	HOCK TO NAIL	HOCK TO PAD	PAD WIDTH	FOOT WIDTH
7															

18 19 22 25 27 29 31 34 39 42 45 48 51 54 57 59 6Ø

Figure 6.
(key to Fig. 5)

TABLE OF VARIABLE NAMES MATCHED TO NUMBERS

1. Month	26. Bilirubin	51. H. Vol.
2. Sex	27. Alk. Phos.	52. MVC
3. Drug	28. L.D.H.	53. MCHC
4. Dose	29. S.G.O.T.	54. % Fat
5. Down Time	30. C.P.K.	55. Excitation
6. Location	31. Calc/Phos. Ratio	56. Condition
7. Repro-stat	32. Protein	57. Heart Rate
8. Age	33. Albumin	58. Resp. Rate
9. Length	34. Globulin	59. Rectal Temp.
10. Hind Ft.	35. Alpha 1	60. Rectal Class
11. Shoulder Ht.	36. Alpha 2	61. Amp. Temp
12. Heart Girth	37. Beta	62. Temp Class
13. Ear length	38. Gamma	63. Zinc
14. Tail Length	39. Alb to Glob Ratio	64. CV
15. Antler Spr.	40. % Albumin	65. Mg
16. Antler Base	41. % Globulin	66. Mn
17. Weight	42. % Alpha-1	67. CA
18. Calcium	43. % Alpha-2	68. Na
19. Phosphate	44. % Beta	69. K
20. Glucose	45. % Gamma	70. Co
21. B.U.N.	46. Wht. Blood Cells	71. Fe
22. Uric	47. Seg Neutral	72. Pb
23. Cholesterol	48. Lymph	73. Ag
24. Protein	49. Differential	74. Age Class
25. Albumin	50. Hemoglobin	

Figure 7. Moose frequency checklist.

Susitna Moose Observation Record

Date of Last Observation

I.D. Number	Frequency	
617	150.172	
618	150.130	
619	150.100	
622	150.180	W/1
623	150.160	
624	150.090	W/1
625	150.200	
626	153.120	♂
627	150.190	♂
628	150.140	W/2
629	153.361	W/2
630	153.400	W/2
631	153.371	
632	153.340	
633	153.330	
634	153.381	W/1
635	153.351	W/2
636	153.501	
637	153.390	W/2
638	153.480	
639	153.460	
640	153.420	W/1
641	153.440	W/2
642	153.470	♂
643	153.491	
644	153.540	W/2
645	153.530	W/2
646	153.430	
647	153.450	
648	153.650	
649	153.660	W/1
650	153.700	W/1
651	153.510	
652	153.670	W/2
653	153.520	W/2
654	150.110	
655	150.150	
656	153.680	
8583	151.770	
8035	151.576	

Figure 8. Moose radio-tracking flight record.

Date ____________ Start ____________

Survey type ____________ Pilot ____________ Stop ____________

Observer ____________ Keypunched /__/ Duration ____________

Frequency (153.)							
Strong Frequency							
Collar number							
Sex and age							
Location							
Visual obs.							
Habitat							
Time							
Activity							
# of young							
Group size							
# of ♂							
# of ♀							
# of calves							
Elevation							
Slope							
Aspect							
Antlers							
Wind dir.							
Wind speed							
Cloud cover							
Temperature							
Snow depth							
Snow cover							
Remarks							

MOOSE RELOCATION RECORDS

Collar No. __________ Frequency _____________ Sex ________ Year Born ____________ Accession No. ________________

Obs. No.	Date	Time	Location Tnsp	Rang	Sect	Visual Y/N	Habitat (see code sheet)	Activity	Association	Elevation	Slope	Aspect	Snow Depth	Picture	Comments	Key Punch.

Radio-tagged Caribou Aerial Survey Figure 10.

Date______________ Weather______________________________ Pilot/Observer____________________

Freq. (152.)									
Str. Freq.									
Collar Number									
Sex and Age									
Last Relocated									
Visual Obser.									
Time									
Location									
Elevation									
Habitat									
Activity									
# of young									
Antlers									
Group Size									
# of calves									
# of adult ♂									
# of adults									
# of unk.									

Remarks:

Figure 11.

Radio-tagged Caribou Relocation Record

Frequency________________________ Sex__________________________

Collar Number____________________ Age__________________________

Obs. #	Map		Location	Visual	Date Time	Elevat.	Habitat	Activity	# Yng.	Ant.	Group Size	# Calves	# Ad.♂	# Ad.	# unk.	Remarks

Figure 12.

Radioed#Bear Observation Sheet, SUSITNA HYDRO PROJECT Page of

Date ____________.

Pilot/Observer ____________.

Weather ____________

____________.

Time took off:	Time landed:	Total Flt. hrs.

Time ON survey	Time OFF survey	Total survey h

HABITAT TYPES(include combinations):

1. Sparse tall spruce
2. Mod. tall spruce
3. Dense tall spruce(riparian)
4. Sparse med. spruce
5. Mod. Med. spruce
6. Dense Med. spruce
7. Sparse low spruce
8. Mod. low spruce
9. Dense low spruce
10. Riparian willow
11. Upland willow
12. Willow birch
13. Aspen
14. Riparian hardwood
15. Marsh
16. Alder
17. Rock/ice

Bear #, sp., & (frequency)	Map # & location	Visual? (flag color)	Time	Habitat	Slope	Aspect	Activity	Assoc. # & sex (marked? cubs?)

Include observations of non-radioed bears, pinpoint on map and first column with a letter(a,b,...Z) and date, indicate species.

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Relocation Records for Black/Brown Bear #____________. Sex=_______, Age=__________, Frequency=__________.

Animals with overlapping frequencies=______________________________.

Obs. #	Quad #	Visual? yes/no	Date/time	Side of River	Habitat	Elevation	Slope	Aspect	Activity	Association	Comments

Page #______. To continuation page #______.

Figure 14.

WOLF/WOLVERINE SUSITNA RIVER PREDATION STUDY

Date ________ Observer ________ Flight time ____________

MAP LOCATION NUMBER	Pack & Wolf ID #	Number & Color in Pack	Activity	Species, age & % Consumption of Kill	Habitat Type

Notes on wolf activity

WOLVERINE OBSERVATION FORM

Wolverine Accession # ________

Date	Map #	Time	Visual Yes/No	Habitat	Aspect & Slope	Activity	Direction Of Travel	Association	Comments & Observations

Radio-Tracking schedules will not be rigidly set and will be varied to respond to changing conditions, however, the following schedule will serve as a guide.

1. Moose - approximately once every 10 days, but more frequently during spring and fall migration and calving periods.
2. Wolf - approximately weekly.
3. Wolverine - approximately weekly.
4. Bear - approximately every 10 days during most of the non-denning period, but more frequently in spring and fall to determine locations of dens, pre and post denning movements and post-emergence habitat requirements.
5. Caribou - approximately one month intervals except during calving season, the post-calving aggregation period, the breeding season and when animals are concentrated near the proposed impoundment when more frequent surveys will be flown.

C. <u>Aerial Distribution Surveys</u>

Surveys will be made from fixed-wing aircraft (PA 18-150) to determine patterns of distribution of moose and sheep. The aircraft with a pilot and one observer will be flown at low level along systematic but not predetermined flightlines. Flightlines will usually be parallel, but will tend to follow elevation contours in mountainous terrain. Spacing of tracklines will be designed to provide almost total coverage of the area. A direct visual count of all animals sighted will be made. Each animal will be classified by sex and age class to the extent possible (Figs. 16-19).

The intent of these surveys will be to determine the distribution of animals over an area. It is desirable to locate as many animals as possible, but these are not censuses and consequently, sampling procedures appropriate for population estimates will not be used.

D. <u>Caribou Census and Composition Counts</u>

A modified version of the aerial photo-direct count-extrapolation census procedure (Hemming and Glenn 1969, Davis et al. 1979, Doerr 1979) will be used to estimate the size of the Nelchina herd. This technique is composed of three separate procedures: (1) a complete count of all animals in the post-calving aggregation; (2) a composition count of these same animals to determine the proportion of adult females; and (3) a representative fall composition count of the entire herd to determine the proportions of females, males and calves (Doerr 1979). Acceptance of four assumptions are necessary for the APDCE technique: (1) all females in the herd are present in the post-calving aggregations; (2) adult females are randomly distributed throughout the post-calving aggregations; (3) the sex and age cohorts are randomly distributed throughout the herd during fall; and (4) mortality of adult females from the time of post-calving aggregation to the fall composition counts is zero (Davis et al. 1979). An evaluation of these assumptions by Davis et al. (1979) indicated that all but assumption #3 were valid and that the collection of representative fall composition data was the most difficult procedure.

Figure 16. Moose composition count form.

AREA: ______________ PILOT & OBSERVER: ______________ DATE: ________

WEATHER & SNOW CONDITIONS: ____________________________

TYPE OF PLANE: ______________ TIME OFF: ________ TIME ON: ________

PAGE NUMBER: ________

BULLS		COWS								
Large	Small	W/O Calves	W/1 Calf	W/2 Calves	Lone Calves	Unid. Sex & Age	Time Count Started & Ended	Timber-line & Above	Below Timber-line	REMARKS

B.G.D.I.F. Code: C-2 Sex & Age Ratios

MOOSE G.M.U.______ Specific Area____________________________________

19______ Submitted by:____________________________

Date	Tot. ♂ per 100 ♀	Sm. ♂ per 100♀	Sm. ♂ Per 100 Lg. ♂	Sm. ♂ % in Herd	Sm. ♂ Per 100 ♂ calves	Calves per 100 ♀	Incidence of twins per 100 ♀ w/calf	Calf % in herd	Animals per hour	Total sample

Remarks:

gure

B.G.D.I.F. Code: C-2 Sex and Age Composition

MOOSE G.M.U.________ Specific Area____

19______ Submitted by:______________________________

Date	large ♂	small ♂	total ♂	♀ w/0	♀ w/1	♀ w/2	total ♀	total adults	lone calves	total calves	unid. sex & age	total sample	count time (hrs)

Remarks:

Figure 19.

GOAT COUNT FORM

AREA ______________ Page _____ of _____

Date ______________ Time Off __________ Time On __________ Total Flight Time __________

Observer ______________ Pilot ______________________ Aircraft Type ______________

Weather ______________________________ Snow Conditions ______________________________

General Counting Conditions ____

Time Start Count __________ Time and Count __________ Counting Time ______________

Area & Notes	Goats			Sheep					
				Rams					
	Adults	Kids	Unid.	Legal	Sublegal	Unclas.	Ewes	Lambs	Unid.

The fall population estimate is calculated from the following equation (Doerr 1979).

$$FP = N_a \times P_f \times S_f \times (1 + R)$$

where

FP = estimated fall population;

N_a = number of animals in the postcalving aggregation;

P_f = proportion of females in post-calving aggregation;

S_f = survival of females from the time of the post-calving counts until the fall; and

R = ratio of caribou other than females to females in the fall.

Reconnaissance flights will be made in a C-180 to determine when caribou are suitably aggregated to census. PA-18-150 Supercubs will be used to survey the aggregations and the caribou herds will either be photographed or directly counted. Hand-held, motor driven, 35 mm cameras will be used to photograph caribou groups. The 35 mm color slides of caribou groups will be projected on a paper screen and caribou images marked. The number of images are then counted.

A helicopter (Bell 206B) will be used to sample the post-calving aggregations and the herd during the breeding season to estimate proportions of females, males and calves. Groups of caribou will be approached from the rear until the sex of each animal older than calves can be determined from the external gentalia (presence or absence of the vulva).

E. Moose Census

Moose populations will be censused by quadrat sampling techniques developed by Gasaway (1978) and Gasaway et al. (1979). A 37 page manual prepared by W. C. Gasaway for use by individuals applying these techniques is on file in the Fairbanks, Anchorage and Glennallen ADF&G offices. Some modification of the technique may be necessary to adapt it to the upper Susitna area. Personnel currently engaged in moose survey procedures development will assist in the final design of the census technique.

F. Browse Utilization/Pellet Group Studies Downstream Moose

To determine habitat use by moose along the Susitna River, browse-plant utilization and pellet groups will be recorded along transects across the river. The river below the Devil's Canyon dam site will be subdivided into three sections based on physiography, access and moose use. These will be (1) Dam site to Talkeetna; (2) Talkeetna to Montana Creek; and (3) Montana Creek to Delta Islands.

Initially, transects will be conducted in upper, middle and lower portions of each section to provide a broad picture of moose use of the entire area. This information will provide a basis for selection of future sites for more comprehensive sampling and determining the most appropriate sampling techniques. Transects will follow existing section lines. The number of browse plants available to moose and the number actually browsed by moose (or hare and beaver) will be recorded within a strip one meter wide along the entire transect. The transect will be divided into 10 meter sections and the habitat type of each 10 meter section will be noted. Pellet groups will be counted within one meter on both sides of the tranect line within each 10 meter section. Only the first 100 meters of upland habitat on opposite banks of the river will be surveyed at each transect.

Five browse species will be considered: willow (Salix sp.), cottonwood (Populus balsamifera), paper birch (Betula papyrifera), high bush cranberry (Viburnum edule) and rose (Rosa acicularis). They will be considered "browsable" if they are over 40 cm tall (i.e. are available above or near the snowline in winter) and if their circumference at breast height in 13 cm or less (this circumference has been determined to be the maximum that can be broken over by moose while foraging). To be counted as seaparate stem from a cluster of stems, the plant must be surrounded by soil or if it is a "sucker" on a cut-off stump or mature tree it must be at an angle of 45 degrees or less from the main stem of the plant. If it is between 45 degrees and perpendicular (90 degrees) to the trunk, it will be classified as a branch and not a browse stem.

Only pellet groups containing 12 or more moose droppings and with their approximate geometric center within the transect will be counted.

The habitat classification will follow Viereck and Dyrness (1980) as closely as possible. Additionally, the density and height of plants will be recorded (see Figs. 20-22 for more details).

Portions of the lower river will be selected for more intensive sampling. In these areas, 2 x 2 meter plots will be used to determine browse availibility/utilization. Pellet groups will be counted in circular plots with 2 meter radius at the same locations as the browse availability/utilization plots. These plots will be spaced every 20 meters along randomly selected transects. The smaller plot size was chosen to better fit within given habitat types. The number of transects will be limited by the amount of time between breakup and leaf emergence.

G. Den Site Characteristics

Bear, wolf and wolverine den sites will be marked by dropping either with flagging or radio collars from the air. When the animals have left, the dens will be visited so that characteristics of the site can be recorded. Information to be recorded will include:

Figure 21.

Codes for Susitna Hydroelectric

Downstream Moose Browse/Pellet Studies

Byte	Subject
1-6	Date (Day, month, year)
7-9	Transect Number (Byte 7, Section of river: 1 = upper, 2 = middle, 3 = lower; Bytes 8-9, number of transect)
10-11	Distance between plots (blank = continuous plots, 1 = 20 m)
12	Plot Size - vegetation (1 = 1 x 10m, 2 = 2 x 2m)
13	Plot Size - pellets (1 = $\pi 2^2$m, 2 = 2 x 10m)
14	Section Number (Occasionally there was a break in continuity of a transect because an island was too large to do it in its' entirety. Therefore, a section number was given to each continuous portion of the transect.)
15-16	Plot number (numbered consecutively from east to west)
17-24	Habitat - major (17 - Density [1 = open, 2 = sparse, 3 = medium, 4 = dense], 18 - Height [1 = low, 2 = medium, 3 = tall, 4 = climax], 19 - Level I: Viereck and Dyrness (1980), 20 - Level II, 21 - Level III, 22 and 23 - Level IV and 24 - Level V.
25	Quarter (Number of quarters in which the major habitat was found e.g. 4 if all of one habitat was within the plot)
26-33	Habitat - minor (same as Habitat - major)
34	Water's edge (1 if the plot bordered a stream channel, blank if it was an internal plot)
35-40	SCS code for the same habitat type.
41-48	Willow (41-42: number of browsable plant available, 43-44: number of plants browsed by moose, 45-46: number of plants browsed by hare, 47-48: number of plants browsed by beaver.

Byte	Subject
49–56	Cottonwood (categories same as for willow)
57–64	Paper Birch (categories same as for willow)
65–72	High Bush Cranberry (categories same as for willow)
73–80	Rose (categories same as for willow)
81–82	New Pellets (number of pellet groups dropped during the previous winter that were found in the plot)
83–84	Old Pellets (number of pellet groups from 2 or more winters previous to sampling)

Figure 20.

SU HYDRO - DOWNSTREAM MOOSE BROWSE/PELLET STUDIES

Page ____ of ____

	DATE (D M Y)	Transect	Dist. Bet. Plots	Plot Size (Veg)	Plot Size (Pell)	Sect. No.	Plot No.	HABITAT (major) D H I II 3 IV V	Quarter	HABITAT (minor) D H I II 3 IV V	Water's Edge	SCS Codes	WILLOW				COTTONWOOD				BIRCH				H.B. CRANBERRY				ROSE				New Pellets	Old Pellets	
													Avail.	Moose	Hare	Beaver	Avail.	Moose	Hare	Beaver	Avail.	Moose	Hare	Beaver	Avail.	Moose	Hare	Beaver	Avail.	Moose	Hare	Beaver			
	1 2 3 4 5 6	7 8 9	0 1	2	3	4	5 6	7 8 9 0 1 2 3 4	5	6 7 8 9 0 1 2 3	4	5 6 7 8 9 0	1 2	3 4	5 6	7 8	9 0	1 2	3 4	5 6	7 8	9 0	1 2	3 4	5 6	7 8	9 0	1 2	3 4	5 6	7 8	9 0	1 2	3 4	5 6
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Table 22.

HABITAT CLASSIFICATION SCHEME
Susitna Hydro - Downstream Moose

DENSITY	HEIGHT	MACRO HABITAT (Visual or Nonvisual) Dominant Species greater than 75%	(Mixed if 25-75%) :	Other Species less than 25% +	Understory Species /	MICRO HABITAT (Visual only) Species
O - Open (10% or less)	L - Low (Young, Small) (5 ft. or less)	Cottonwood or Balsam poplar - Cott			Will	
S - Sparse (Woodland) (10-25%)	M - Medium (5-20 ft.) (prime moose browse)	Aspen - Aspe			Alde	
M - Medium (Open, Moderate) (25-60%)	T - Tall (20-30 ft., 2-5 in. dbh) (Too thick for moose to break)	Paper Birch - Birc			Elderberry - Elde	
D - Dense (Closed) (60-100%)	C - Climax (30 ft. or higher) (5 in. or greater dbh) (mature timber)	Black Spruce - BlSp			Ferns - Fern	
		White Spruce - WhSp			Calamagrostis - Cala	
		Unid. Spruce - Spru			Forbs - Forb	
		Alder - Alde			Grasses - Gras	
		Willow - Will			Equisetum - Equi	
		Muskeg - Musk			Sedges - Sedg	
		Tundra - Tund			Cow Parsnip - Hera	

EXAMPLES: M C Birc:Spru + Cala / Musk , S M BlSp + Forb (no micro)

SLOPE		ASPECT
Flat	0-10°	8 Points of the compass
Gentle	10-30°	
Moderate	30-60°	
Steep	60-90°	

1. Location
2. Elevation relative to flood line
3. Slope
4. Aspect
5. Habitat
6. Physiography
7. Den size
8. Vegetation in den
9. Sex and age of animals using the den
10. Soil type
11. Proximity to water
12. Scats will be collected

H. Snow

Permanent snow courses, in addition to those maintained by SCS and R&M will be established. These courses will be arranged along lines extending from the Susitna River to higher elevations above the levels of proposed impoundments to aid in the correlation of big game (primarily moose) movements in and out of the impoundments areas with snow conditions. Additional snow depth and hardness measurements will be made periodically in areas of animal concentrations or recent animal movements. Techniques will be the same as those used by R&M to ensure compatability of data.

I. Scat Analysis

Wolf, wolverine and bear scats will be collected whenever available to determine food habits. Scat contents will be identified with aid of a reference collection currently maintained at the Glennallen ADF&G office (Fig. 23).

J. Miscellaneous

Sightings of unmarked animals made by project personnel and sightings of both marked and unmarked animals made by non-project personnel will be recorded when the information appears reliable and will contribute to the objectives of the project. Data forms for miscellaneous sightings (Fig. 24) will be distributed to individuals in the project area.

Dead animals encountered in the course of other activities will be recorded. When possible, carcassas will be visited on the ground. Wolf and wolverine carcassas will be purchased from trappers. Data collected will provide insight on causes of mortality, food habits of predators and condition of animals (Figs. 3 and 25-28).

III. DATA PROCEDURES

Data gathered in the field will be recorded on maps, aerial photographs, standardized forms and in some cases, notebooks. Data recorded on aerial photographs will be transcribed on maps of the same approximate scale. These maps, all field maps, all field data forms and notebooks will be preserved as a permanent record of each field trip.

Figure 23.

MI - Microscopic

PRESENCE OF FOOD ITEMS IN WOLF SCATS

Code #	Sample Area
Moose Adult	
Moose Calf	
Caribou Adult	
Caribou Calf	
Beaver	
Snowshoe Hare	
Parka Squirrel	
Microtine	
Bird	
Fish	
Wolf	
Vegetation	

Figure 24.

DATA FORM FOR MISCELLANEOUS BIG GAME AND FURBEARER OBSERVATIONS-SUSITNA RIVER PROJECT

Use for observations of wolf, fox, coyote, lynx, wolverine, river otter, mink, bear, marked moose, marked caribou, beaver dam and den site. Please try to pick up a skull, jaw, long bo ɔd hair sample of any dead animals of these species encountered, including unmarked indivi

DATE ________. TIME ________ am/pm. OBSERVER ________. PROJECT ________

SPECIES (Check one):

/__/ brown bear
/__/ black bear
/__/ wolf
/__/ coyote
/__/ fox
/__/ wolverine
/__/ river otter
/__/ mink
/__/ collared moose
/__/ collared caribou
/__/ beaver dam or pon

IDENTIFYING MARKS (if any): Collar color ________.

Numeral color and number (if any): ________. Ear Flag Color ________ right/left

Other marks (describe): ________

LOCATION: ________ (map name, 1:250,000), ________ (Quad. number, 1:63,360, ________ (other map-specify)

Specific Location Description: ________

Type of Vegetation ________

COMPANION ANIMALS PRESENT: ________ (number), ________ (sex/age/size?), ________ (identifying marks?)

ACTIVITY

/__/ 1. Dead
/__/ 2. Resting or bedded
/__/ 3. Feeding
/__/ 4. Walking
/__/ 5. Running
/__/ 6. Fishing
/__/ 7. Digging
/__/ 8. Swimming
/__/ 9. Standing
/__/10. Obviously hunting or attacki ________ (species

Other activity ________. Direction moving ________

DEN SITE /__/ OR BEAVER DAM /__/ OBSERVATIONS: Animals observed at den site or beaver dam? /__/ yes, /__/ no.

Description of den site or beaver dam and animals observed: ________

Please specify the specific location of den sites or beaver dam and attach a map if possibl

Map attached? /__/ yes, /__/ no.

PREY SPECIES (for predators specify if on a dead animal, species of prey, freshness of kill)

Specimens collected: /__/ jaw, /__/ skull, /__/ long bone, /__/ hair.

How are specimens labeled and stored? ________

GENERAL COMMENTS:

Return to: Susitna Project, ADF&G, Game Division, 333 Raspberry Rd., Anchorage 99502.
THANKS!!

Figure 25.

Wolverine Data Form

Accession #__________

Collector's Name ____________________ Seal Number ________

Address ____ Sealing Date ________

Tag Number ____________ Measured By ____________

Specific Location of Capture ____

Method of Harvest ________________________

Age __________________ Based on: tooth __________ Skull __________

Leg Bone __________ Os Baculum __________

Sex ____________

Animal accompanied by any other wolverines, and what was their activity? __________

____

Specimens Collected (check):

Skull ______ Tooth ______ Blood ______ Hair ______

Os bacumum ________ Repro. tract ______________ Adrenal ________

Thyroid __________ Diaphram ________ Liver _______ Stomach contents ______

I.D. ____

Weight (kg) ________ Leg Bone(s) ___________

Special notes ____

____

MEASUREMENTS:

Carcass and hide __________

Carcass only __________

Hide only __________

Depth of rump fat __________

Depth of flank fat __________

Depth of back fat __________

Dept of sternum fat __________

Height __________

Neck circumference __________

Nose to base of tail __________

Base of tail to last vertebrate __________

Rear right hock to nail tip __________

Length of right ear __________

Width of right front paw __________

Raw skull length ________ Width ________

Skull length ________ Width ________

Length upper canine ________ Width ________

Heart girth __________

MISCELLANEOUS NOTES: ________________________

____

Figure 26.

Moose Data Collection Form

Accession ____________ Date ____________

Sex ____________ Age ____________ Physical condition ____________

Items collected:

Femur ________ Tooth ________ Hair ________ Other ________

Suspected cause of death ________________________________

Location ________________________________

Description of kill:

Date items sent in

Femur ________ Hair ________ Teeth ________ Other ________

Date data received

Femur ________ Hair ________ Teeth ________ Other ________

Figure 27.

Caribou Data Collection Form

Accession __________ Date _______________

Sex __________ Age __________ Physical condition ____________________

Items collected:

Femur _________ Tooth __________ Hair __________ Other __________

Suspected cause of death ____

Location ____

Description of kill:

Date items sent in:

Femur __________ Hair __________ Teeth __________ Other __________

Date data received:

Fenur __________ Hair __________ Teeth __________ Other __________

Figure 28.

BONE MARROW DATA FORM

Accession No.______________ Collector______________ Unit__________

Species______________ Age_______ Sex (circle one): ♂ ♀ ?

Collection Date______________ Collection Location______________

Specimen: Femur __________
Metacarpus__________
Metatarsus__________
Ramus, right__________
Ramus, left__________
Other__________

Oven Temp = 55°C

Date	Gr.Wt.	Date	Gr.Wt.

$$\% \text{ Fat} = \frac{\text{Net dry wt}}{\text{Net wet wt}} \times 100$$

Net dry wt = gross dry wt - tare
Net wet wt = gross wet wt - tare

Tare wt = __________

Gross wet wt = __________

Net wet wt = __________

Gross dry wt = __________

Net dry wt = __________

TOTAL DRYING TIME (days)_______ % FAT = __________

Bone Marrow Color: RED_______ PINK_______ WHITE_______
(prior to drying)

APPEARANCE OF MARROW IN CAVITY:____________________

REMARKS:____________________

Another set of maps and data forms will be maintained in the office for each marked animal. Data will be transcribed from field maps and forms to these forms after each field trip. These records will be maintained in files or looseleaf notebooks along with any other information specific to that individual animal such as tagging forms, sealing documents from harvested animals and miscellaneous observations.

Tabular data will be keypunched and stored on magnetic tape (University of Alaska equipment).

Map based data will be digitized with an Alaska Department of Natural Resources digitizer and stored on magnetic tape.

Data on habitat type generated by University of Alaska personnel conducting plant ecology studies and other pertinent variables (topography, aspect hydrologic features, etc.) will also be digitized. The above data sets will be analyzed to determine home ranges and correlate animal location with environmental factors. These analyses will be done using Alaska Department of Natural Resources geoprocessor software (ALARS) and Data Eclipse hardware. The extent to which these analyses will be carried out will depend on the results of a pilot study which will be conducted in late 1980.

IV. QUALITY CONTROL

All original forms and maps will be retained permanently. Data recorded on aerial photos will not be retained permanently because of the cost of photos, but will be carefully transcribed on USGS maps.

Transcriptions of data and keypunching will be verified by commonly accepted procedures. Computer program outputs will be checked with hand calculators and manual plots of data.

Radio relocations of animals and identification of individuals will be confirmed through visual contact whenever possible.

Consistency in data collection will be maintained through frequent exchange of personnel among the various big game projects.

V. SCHEDULE

See Figure 29.

VI. PERSONNEL

Key big game project personnel are the study coordinator (Game Biologist IV) and principal investigators of the individual projects (Game Biologist III). The attached class specifications (Figs. 30 and 31) describe the minimum qualifications for these positions. Individuals currently employed in these positions are:

Fig. 29 Schedule of Phase I Big Game Study Activities

ACTIVITY	1980												1981												1982	
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Literature Review	X	X	X	X	X																					
Planning and Equipment Purchase	X	X	X	X																						
Animal Tagging (Major Efforts)				X	X						X	X			X	X										
Radio Tracking					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Moose Survey			X	X							X	X	X	X	X	X							X	X		
Sheep Survey							X								X											
Caribou Census						X												X								
Caribou Composition Count						X				X								X				X				
Pellet Group - Browse Utilization Survey						X	X	X										X	X	X						
Data Analysis											X	X										X	X	X		
Annual Report Preparation												X	X											X	X	

STATE OF ALASKA

Class Specification

GAME BIOLOGIST IV

6144-20

Definition:

Under general direction of the Game Research Chief or Regional Supervisor, supervises and is responsible for game research or management projects at the regional level.

Distinguishing Characteristics:

This is the second supervisory level in the Game Biologist series and is distinguished from the Game Biologist III class by responsibility for general direction of one or more first level supervisory Game Biologists, planning and directing complex research programs and for the coordination of activities for research projects involving the use of diverse funding. Assignment may also be made at the regional level as a leader of an Outer Continental Shelf research function (marine mammals - marine birds).

Examples of Duties:

Designs, plans, and supervises the implementation of game management or research programs, which consist of several projects; coordinates statewide projects, such as federally-financed research and developmental projects, special grants by industry, institutions and the federal government for studies and other special projects.

Provides direction and assistance to subordinate biologists to achieve optimum results in the assigned projects; designs and monitors the procedures for the collection and storage of biological and statistical data.

Prepares technical and administrative reports for department, public or scientific use.

Reviews and plans and budget needs of research biologists through consultation and coordination with professional staff members and their activities.

Participates actively in public meetings as division representative. Maintains cooperation with other department divisions, other state agencies and federal agencies.

May be assigned as a regional leader in the federally funded Outer Continental Shelf research program.

Performs other related duties.

Knowledges, Skills and Abilities:

Knowledge of: Principles and practices of vertebrate biology, habitat requirements of game species, research techniques, supervisory principles.

Skill in: The use of laboratory and field equipment.

Ability to: Analyze and determine ecological and harvest variables, plan, organize and direct detailed projects involving professional and non-professional personnel; supervise the work of others and maintain effective working relationships with associates, other agencies and the public; prepare comprehensive scientific management or research reports and records in relation to traditional and emerging concepts, findings and techniques; speak and write effectively.

Minimum Qualifications:

(1) PhD in biology, zoology, ecology, wildlife management or a closely related field and two years of experience as a Game Biologist III with the State of Alaska or the equivalent elsewhere.

OR

(2) Master's degree in one of the above fields and four years of experience as a game biologist including two years as a Game Biologist III with the State of Alaska or the equivalent elsewhere.

OR

(3) Bachelor's degree in one of the above fields and five years of satisfactory experience as a game biologist including two years as a Game Biologist III with the State of Alaska or the equivalent elsewhere.

Substitution: One year of experience as a fish biologist may be substituted for one year of the required general experience in option #3.

Orig: 7/01/69
Rev: 2/16/74
Rev: 6/01/75

STATE OF ALASKA

Class Specification

GAME BIOLOGIST III

6143-18

Definition:

Under direction, is responsible for game management or research projects as (1) an area management game biologist or (2) assistant area game biologist in a complex management area or (3) project leader of a research or development project.

Distinguishing Characteristics:

Positions assigned to this class may be project leaders specializing in a federally financed study of the Outer Continental Shelf and its specific ecosystems (marine mammals, marine birds).

Examples of Duties:

Designs, budgets, plans and implements game management activities for a management area or a research project that may be on-going in several areas of the state.

Analyzes and evaluates statistics and reports. Make management decisions which affect area-wide harvest by opening or closing areas, or limiting harvest permits. Compiles data to prepare comprehensive statistical reports and to form a basis for continuing projects.

Assists the area management biologist in interpretation of research results for management application. Proposes regulation changes or implements emergency orders that change harvest regulations.

Designs, supervises and conducts population (dynamics), behavior, population identity, distribution, transplant feasibility, habitat improvement and other studies as appropriate.

May supervise and direct a research project or jobs about which little valid and reliable information is available.

Determines exploitation rates which specific game populations can sustain under different environmental conditions.

May serve as division project manager of a statewide program having national significance such as Hunter Safety Education.

Has frequent public contact and may represent the state in such contacts. May act as state representative in cooperating with state and federal agencies.

May serve as a project leader with specific assignment in a study of the Outer Continental Shelf.

May supervise subordinate biologists; technicians and clerks.

Performs other related duties as required.

Knowledges, Skills and Abilities:

Knowledge of: Principles and practices of vertebrate biology and of various field survey and field and laboratory analysis techniques; vertebrate pathology and nutrition, and habitat requirements of game species common to or capable of culture in Alaska.

Skill in: The use of laboratory and field equipment.

Ability to: Analyze and determine ecological and harvest variables, plan, organize and direct detailed projects involving professional and non-professional personnel; supervise the work of others and maintain effective working relationships with associates, other agencies and the public; prepare comprehensive scientific management or research reports and records in relation to traditional and emerging concepts, findings and techniques; speak and write effectively.

Minimum Qualifications:

(1) PhD in biology, zoology, ecology, wildlife conservation or a closely related field.

OR

(2) Master's degree in one of the above fields and two years of experience as a Game Biologist II with the State of Alaska or the equivalent elsewhere.

OR

(3) Bachelor's degree in one of the above fields and three years of experience as a game biologist including two years as a Game Biologist II with the State of Alaska or the equivalent elsewhere.

Substitution: One year of experience as a fish biologist may be subistituted for the required general experience in option #3.

Orig: 7/01/69
Rev: 7/08/71
Rev: 11/01/73
Rev: 2/16/74
Rev: 6/16/74
Rev: 6/01/75
Rev: 5/1/77

Big Game Studies Coordinator:	Karl B. Schneider Alaska Department of Fish and Game 333 Raspberry Road Anchorage, Alaska 99502 M.S., 18 years research experience in Alaska, 8 years as supervisor or regional research staff. Projects supervised have been directed at variety of big game, marine mammal and marine bird species and include major elements of impact assessment programs.

Principal Investigators

Upstream Moose, Wolf and Wolverine:	Warren Ballard Alaska Department of Fish and Game P.O. Box 47 Glennallen, Alaska 99508 M.S., 13 years experience in wildlife research and management programs, 7 years in Alaska. Experience includes impact assessment on Corps of Engineers reservoirs. Most recently, has conducted extensive multi-species predator/prey research in the Nelchina Basin.
Downstream Moose Project:	Paul Arneson Alaska Department of Fish and Game 333 Raspberry Road Anchorage, Alaska 99502 M.S., 12 years experience in wildlife research. Participated in the development of many of the techniques to be employed on the Susitna Project while stationed at the Kenai Moose Research Center. Also has extensive experience in impact assessment.
Bear Project:	Sterling Miller Alaska Department of Fish and Game 333 Raspberry Road Anchorage, Alaska 99502 M.S., Ph.D., 11 years experience in wildlife research and management in the U.S., Chile and New Zealand. Has strong interest in the impacts of various human activities on the distribution and abundance of wildlife. Most recently conducted a study on brown bears in the Nelchina Basin.

Caribou Project:	Kenneth Pitcher Alaska Department of Fish and Game 333 Raspberry Road Anchorage, Alaska 99502 M.S., 12 years experience in wildlife research and management working primarily with marine mammals and moose. Most recent experience was as principal investigator on a major impact assessment project.

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Stratified Random Census Method for Moose

I. Selection of the census area

A. One important point to consider when selecting an area to be censused is the economics of the census

1. It is necessary to evaluate the money and manpower available before deciding on the size of the area to be censused.

B. The selection of an area to be surveyed can be based on two major criteria:

1. Ecological units

a. Drainages

b. Discrete moose populations

2. Nonecological units

a. An area that will be influenced by industrial development

II. Stratification of the census area

A. Stratification is the subdividing of the census area into units having similar moose densities. Stratification of the census area is one of the mose <u>IMPORTANT</u> aspects of the census.

1. Reasons for stratification of the census area.

a. Stratification divides the total population into subpopulations characterized by homogeneous moose density.

1) when an accurate stratification is achieved, a precise estimate of density can be obtained from a relatively small sample of each stratum

EXAMPLE:	NONSTRATIFIED POPULATION	STRATIFIED POPULATION			
		H	M	L	0
Moose density/ sq. mi. in S.U.'s	4,1,0,0,3,2,0,1, 1,2,4,0,0,0,1,1,2	4,4,4,3,4	4,3,3,3,2	1,1,1,2,0	0,0,0,0,0
	this population estimate will theoretically have the highest variance	this population estimate will theoretically have the lowest variance			

b. Stratification also enables the biologist to direct greater sampling effort into those areas that have the highest moose density. The estimation of density in these areas generally has the greatest variance. The variance can be reduced by increasing the proportion of the area sampled.

B. Number of strata to be used in a census area

1. Generally, 3 or 4 strata will be the most practical

a. The number of strata should be influenced by the range of moose densities in the area, and by the ability of the biologist to subdivide the area into subpopulations of varying density.

b. Suggested strata classifications include the following:

1) high moose density

2) medium moose density

3) low moose density

4) zero moose density

2. All strata classifications are relative to a particular census area. For example, high density strata may contain 0.8 moose per square mile in one area, or it may contain 3.2 moose per square mile in another area.

C. The process of stratification

1. Strata boundaries are subjective and the classification may be based in part on prior knowledge for the census area. Therefore, the biologist may have an idea of what constitutes high or low density in the area.

a. Because strata boundaries are subjective, it is advantageous to use a minimum of people in the actual stratification of the census area.

2. The best airplane for stratification is probably a C-185 because it is fast and will carry 2-3 observers.

a. Basis for stratification includes the following:

1) prior knowledge of the area

2) moose density observed

3) density of moose tracks

4) quality and extent of moose habitat

b. It is not necessary to strictly fly standardized transects over the entire area. Over large flat areas of similar habitat, for example, 2 mile transects may be suitable. As the plane approaches an ecotone or an area of dissimilar moose density it may become necessary to intensify the flight time in an area in order to define the strata boundary. Therefore, spend the minimum flight time required to <u>ACCURATELY</u> stratify the area.

c. Each observer should be equipped with 1"/mile topographic maps of the area.

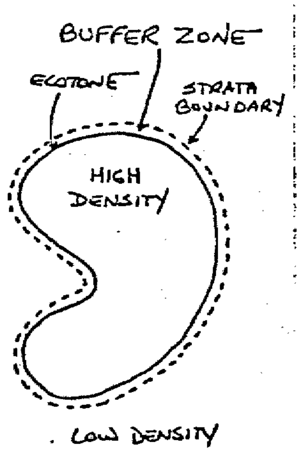
1) as the flight progresses the observers should continuously draw flight lines, the location and number of moose observed, notes on habitat distribution, track density, etc.

2) every attempt should be made to draw strata boundaries during the stratification flight, and when in the vicinity of the boundaries.

3. As strata boundaries are drawn on the map, it is necessary to provide buffer zones around the higher density strata.

a. Buffer zones consist of areas of lower moose density that surround areas of higher moose density.

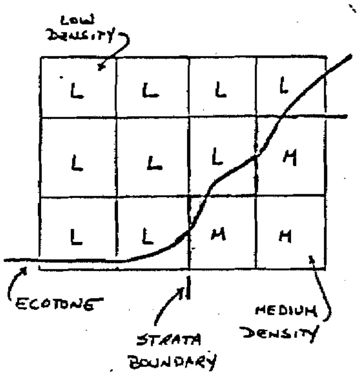
b. The purpose of a buffer zone is to compensate for localized changes in moose distribution that may occur between the time of stratification and the time a sample unit is actually surveyed.



1) If, for example, a burned area is stratified as high moose density, but it is surrounded by a low density black spruce forest, the strata boundary for the burn should include a strip of black spruce around the entire perimeter of the burn.

D. Upon completion of the stratification, the strata boundaries are transferred to mylar overlays of the composit map.

1. At this time strata boundaries may be adjusted slightly to correspond with as many sample unit boundaries as possible. This will simplify surveying the sample units.

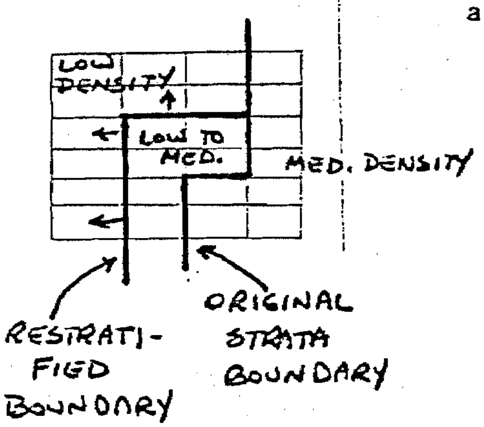


a. When adjusting strata boundaries to follow sample unit boundaries, generally draw the strata boundary so that the sample unit falls into the stratum with the highest proportion of area in the sample unit.

b. If necessary, sample units may be split into halves if a strata boundary bisects a sample unit. However, avoid splitting sample units whenever possible.

E. Changes in strata boundaries during the census.

1. Boundaries may be changed if an error was made during the initial stratification.



a. Sample units (SU) that have been counted prior to the change in boundaries should stay in the initial stratum category. The adjacent area may be moved to a new stratum and sampled at a rate similar to the remainder of the new stratum designation. This assumes that the initial stratification was based on observed moose density.

b. There will be times when stratification was based on habitat type alone. If a homogenous moose density did not continue into an area where it was assumed to continue, then the area can be moved to a new stratum. In this case the area to be reclassified includes SU which have been previously sampled.

F. Timing of stratification

1. Stratification should be conducted just prior to the survey.

   a. Wait for proper survey conditions (snow, etc.), and then stratify the area as rapidly as possible. When the stratification is completed immediately begin surveying in order to minimize moose movements between strata.

   b. Always survey adjacent sample units consecutively, plus any sample units that are close enough together to allow moose movement from one to another.

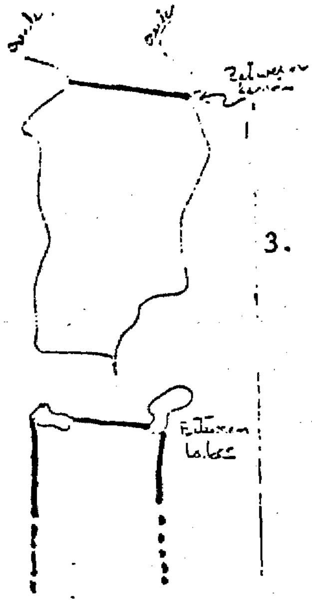
III. Definition and selection of sample units

A. A sample unit is the smallest delineated portion of the area to be censused which has a probability of being selected and searched in its entirety for moose.

B. All possible sample units are described on the 1:63,000 scale maps and given a unique identifying number.

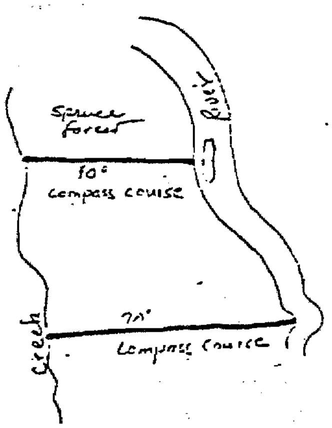
1. The size of sample units should range from 12-15 mi^2; however, some may be out of this range because of the lack of sufficient natural boundaries. Avoid making sample units less than 8 mi^2 and over 20mi^2.

2. Boundaries of sample units are generally creeks, rivers, and ridges; however, straight lines between two identifiable points can be commonly utilized when necessary topographic features are not present on the map. Forks or bends in creeks, lakes, or

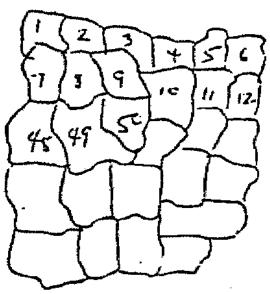


peaks on ridges are convenient sites for straight boundary lines to emanate from (Fig.).

3. Boundaries drawn on maps must be identifiable from the air. The person drawing SU boundaries should be adequately familiar with the area and topographic features on maps to draw easily identified boundaries.



There will be occasions when boundaries become vague due to uniform topography. At that time boundaries should be selected which will have a very low probability of having a moose along it. For example, dense spruce forest may have a very low moose density, hence a poorly defined boundary through it presents little problem because moose will not be often encountered. A compass or visual heading may be flown across the area while observations are made from one side of the aircraft only. This flight path establishes the boundary and subsequent flight lines are made towards the interior of the SU (Fig.).



4. Each SU is given a unique number for identification. The numbers are color coded for rapid relocation on the map. Use one color for each 50 SU and keep the color in a tight block (Fig.).

5. Sample unit area is large compared to most other sampling method used for estimation of numbers of moose. Experiments in Alaska have demonstrated that sampling variance and confidence interval width can be reduced by the use of large SU.

C. Selecting Sample Units

1. SU which are potentially to be surveyed are selected by a simple random sample.

   a. From a table of random numbers (Table) select SU by their unique identifying numbers. Sampling is without replacement of SU selected. As SU are selected, record in the order of selection the SU number in the appropriate stratum column of Table .

      SU in excess of estimate number need for each stratum will be drawn and held in reserve. The number to be drawn is described later under optimization of sampling effort.

2. SU should be surveyed in approximately the order in which they were selected within each stratum.

   a. The order in which they are surveyed becomes increasingly important as the census nears its end. At the beginning of the census those SU which will be surveyed before the final optimization of sampling effort may be surveyed in the most efficient order.

   b. Some sample units which were selected for surveying may be skipped because of localized poor weather for flying or poor snow. Simply replace this SU with another one from the same stratum in an area with suitable weather conditions.

IV. Survey methods and search effort

A. Search effort will average approximately 4 min/mi^2 for each SU. At this rate approximately 1 SU per hour will be surveyed.

1. The minimum acceptable time is 3 min/mi^2 and the maximum is 5 min/mi^2.

a. Most moose are seen during surveys with 4 min/mi search effort during early winter in most moose habitat of interior Alaska.

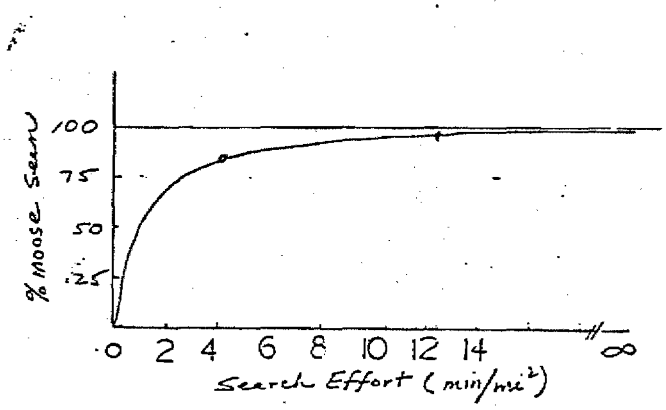


Table 4. Percent radio-collared moose seen in quadrats as categorized by dominant habitat type. Transect/contour data for quadrats with snow given a "poor" rating have been excluded.

	Percent Collared Moose Seen (No. Radio-collared Moose)			
	Transect/Contour		Intensive Search	
Dominant Habitat	Oct/Nov	Feb/Mar	Oct/Nov	Feb/Mar
Shrub-dominated				
Recent burn	90(21)	73(15)	100(20)	94(18)
Subalpine	100(8)	80(10)	100(8)	100(16)
Forest-Shrub mixture				
Shrub-dominated	80(15)	61(23)	100(15)	97(29)
Deciduous-dominated	83(6)	100(9)	100(6)	100(10)
Spruce-dominated	85(13)	51(51)	86(14)	86(56)
Total	88(64)	63(108)	97(63)	92(130)

2. The appropriate search time for a SU can be calculated by estimating its area in mi^2 from the map and multiplying by 4 min/mi^2.

   a. Practice will be required in gauging your flight pattern so as to complete the SU survey in the appropriate time. Practice should occur prior to the census and both pilot and observer should be familiar with the technique.

3. The search pattern flown varies with the topography.

   a. Flat land: parallel transects are flown at 0.5 mi intervals. Do not exceed 0.5 mi intervals.

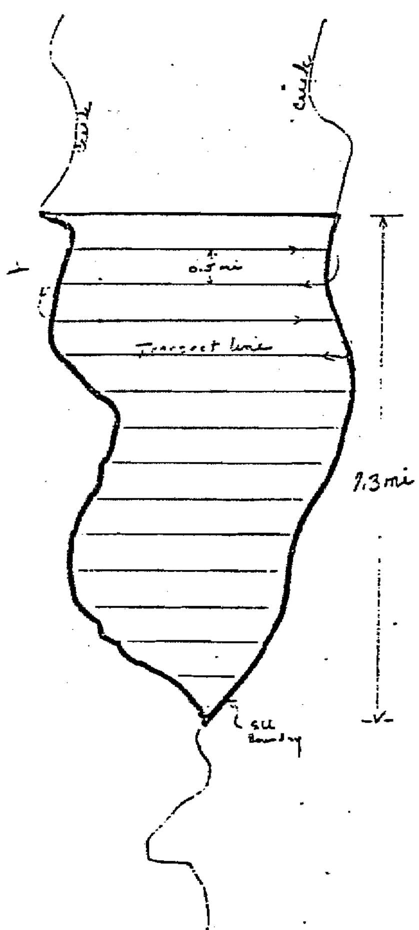
      1) Transects should be short. Choose a compass heading that is perpendicular to the long axis of the SU.

      2) Short transects allow you and the pilot to stay oriented, i.e. not miss areas or overlap too much.

      3) Estimate the number of transects that should be made during the search, i.e. 2x the length of the SU in miles. Make sure no fewer are flown (Fig.).

      4) Mark the approximate location of the transect on the map while turning between transects.

      5) Mark the location of moose on the map while between transects.



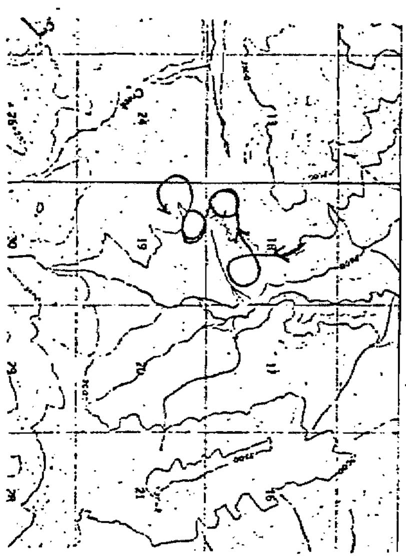
6) The 180° turn between transects will require approximately 40 sec. Make use of this time by recording data, checking flight lines with map references and looking for moose in the SU.

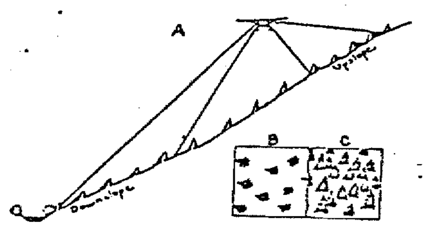
b. Hills and mountains: the flight path generally follows topographic features and consists of contours, routes, circles, and flights along ridges and creeks.

1) Circles are very effective at the heads of valleys and at the ends of ridges (Fig.).

2) Concentrate search effort out of one side of the plane. This reduces the chance of overlooking a portion of the SU. Generally the down slope side of the plane is preferred. However, there are many occasions when viewing from the upslope side will be more practical and effective. For example, very steep slopes and the ends of gently rounded ridges are best viewed from the upslope side of the aircraft.

3) The interval between flight lines is less than 0.5 mi when viewing from 1 side of the aircraft.





A) Amount of hidden ground and perspective of terrain obtained by viewing upslope and downslope during a contour flight; B) Observer's view downslope illustrating top aspect of trees; C) Observer's view upslope illustrating side aspect of trees.

V. Estimating sightability of moose with 4 min/mi^2 aerial search effort.

A. Sightability of moose must be estimated so that the total number of moose present can be estimated. A high search effort of approximately 12 min/mi^2 is repeated in portions of the SU to estimate the total number of moose present. We assume almost all moose are seen during the intensive search.

1. The sightability correction factor (SCF) is estimated as follows:

$$SCF = \frac{\text{\# moose seen during high search effort}}{\text{\# moose seen during low search effort}}$$

a. The SCF will be greater than 1.0 since more moose will be seen with the intensive search.

b. The corrected total moose estimated to be present in the census area is calculated as follows:

$$\text{corrected estimate of number of moose} = SCF \times (\text{estimated no. moose seen during 4 min/mi}^2 \text{ search effort})$$

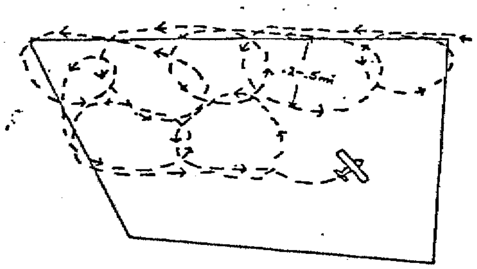
c. This SCF is also used to adjust the confidence interval (CI_a). A new confidence interval is estimated as follows.

$$CI_a = \text{corrected estimated total moose} \pm SCF\,(\text{estimated no. moose during 4 min/mi}^2 \text{ search effort} - \text{lower end of confidence interval of that estimate})$$

c. This is not the correct way to adjust the confidence interval. The method will be changed at a later date.

d. Details of methods of estimating the number of moose and confidence intervals will be discussed later.

2. Expermimental data demonstrate that the number of moose seen on high intensity searches during early winter is a good estimator of the true number of moose present in interior Alaska.
    a. 97 percent radio-collared moose were seen with an intensive search effort of approximately 12 min/mi^2 (Table).
    b. When applying this finding to other areas habitat selection and social behavior are assumed to be similar. If moose differe significantly in a way that reduces their sightability from those in the experimental area this assumption cannot be applied. Experimental work with radio-collared moose in many areas would be needed to verify this assumption.
3. The high intensity search effort applied to plots used for calculating the sightability correction factor is approximately 12 min/mi^2.
    a. Area of plots should be approximately 2 mi^2 so as not to take more than 0.5 hour to search.
    b. Flight path during the intensive search
        1) Flat land: a series of continuous slightly overlapping circles or ovals should be flown (Fig.).
            a) The pilot is responsible for insuring <u>all</u> surface area has been viewed.



Flight pattern (top view) used during intensive search of flat terrain illustrating the elongated, overlapping parallel circling pattern to ensure complete coverage of a quadrat.

b) The radii of circles should be 0.2-0.3 mi. As vegetational canopy height and density increase the turning radius should decrease.

c) Observations are made from the low wing side.

2) Hills and mountains: Fly close contours and make frequent circles. This search pattern is similar to that used for the SU except contours are closer and circling is more commonly used.

4. Selection of high intensity search plots.

a. Approximately 20 plots should be intensively searched.

b. Plots are located within SU from the high and medium density strata only.

1) Select a random sample of 20 SU from those previous selected for the census.

2) Divide each of these 20 sample units into approximately 4 quarters and randomly select 1 quarter from each SU. The plot to be intensively searched should be located in this quarter.

3) The plot will be identified immediately prior to searching the sample unit. Upon completion of the search at an intensity of approximately 4 min/mi^2 the plot is intensively searched.

4) Moose observed in the SU must be mapped accurately with reference to the plot

boundaries during the low and high intensity searches.

5) Do not search the plot with different effort during the low intensity search.

VI. Recording observations on the moose census survey form

A. Routine information includes the following

1. Sample unit no.
2. Date
3. Start and stop time of the sample unit survey
4. Page
5. Location
6. Weather

B. Additional information includes

1. Habitat description

a. The dominant habitat within the sample unit should be classified as one of two major types, with further subdivisions under each general category as follows:

1) shrub-dominated

a) recent burn

b) subalpine

2) forest-shrub mixture

a) shrub-dominated forest

b) deciduous-dominated forest

c) spruce-dominated forest

b. Depending on moose habitat selection patterns in a particular census area, it may be necessary to base sightability correction factors on the dominant habitat recorded for sample units.

2. Snow

   a. Snow conditions have a profound influence on moose sightability and should be classified based on the following subjective components.

      1) age of the snow

         a) fresh

         b) moderate

         c) old

      2) snow cover

         a) complete

         b) distracting amounts of bare ground or herbaceous vegetation showing

         c) fresh snow on trees and shrubs

      3) a combination of snow cover and age can be used to rank the quality of snow conditions in each sample unit as good, moderate, or poor (Table).

         a) an attempt should be made to standardize the snow conditions under which a census is conducted

3. Light conditions

   a. The type and intensity of light should be classified into the following components:

      1) type of light

         a) bright

         b) flat

2) intensity of light

a) high

b) medium

c) low

b. The intensity of the light is relative to the season of the year. High intensity light during October, for example, is not as intensive as high intensity light during July.

c. As yet no effect of light on sightability of moose has been documented; therefore, survey under all conditions. However, flat/low seems most difficult to observe under.

d. Yellow glasses seem to improve contrast under low light conditions.

4. Habitat selection

a. Initial habitat selection by the moose should be recorded as one of the following:

1) herbaceous

2) low shrub--shrubs up to 6 feet in height

3) tall shrub--shrubs from 6 to 12 feet in height

4) deciduous forest

5) sparse spruce forest

6) spruce forest

7) larch

5. Moose spotted during sample unit surveys should be recorded by aggregations.

6. The activity of moose on the initial sighting should be recorded as lying or standing.

VII. Calculation of the population estimate and confidence interval

A. Calculation of the population estimate and variance of the population estimate for an individual stratum. The following calculations will be performed for each stratum.

1. The following symbols will be used for the calculation of the population estimate and variance.

A = total surface area (square miles) per stratum

y_i = number of moose in the i^{th} sample unit (S.U.)

x_i = number of square miles in the i^{th} S.U.

$\bar{x}$ = mean size of all S.U. surveyed per stratum

n = number of S.U. selected per stratum

N = total number of S.U. per stratum

$\hat{T}$ = total population estimate per stratum

2. The density of moose in a stratum is calculated with the ratio estimator (r) as the estimated number of moose per square mile in the stratum.

$$r = \frac{\text{total no. of moose observed in all S.U.'s}}{\text{total surface area of all S.U. (sq. mi.)}} = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} x_i}$$

3. The population estimate per stratum is calculated as:

Stratum pop. est. = density of moose x (total surface area of the stratum)

<u>or</u>

$$\hat{T} = r \cdot A$$

May be programed on an HP97 Calculator

4\. Calculation of variance for the stratum population estimate $\{V(\hat{T})\}$.

a. One advantage of using a simple random sample versus other sampling types (i.e. sampling proportional to size) is that a finite population correction factor can be incorporated into the calculations, thereby reducing variance.

1) The finite correction factor reduces the variance of the estimate as the number of S.U. surveyed increases.

$$V(\hat{T}) = A^2 \cdot \left[\frac{1}{\bar{X}^2} \cdot \frac{s_\delta^2}{n} \underbrace{\left(1 - \frac{n}{N}\right)}_{\text{FINITE POP. CORRECTION FACTOR}}\right] \quad \text{WHERE,}$$

$$s_\delta^2 = \frac{\left[\sum \begin{pmatrix}\text{NO. OF MOOSE}\\ \text{IN EACH S.U.}\end{pmatrix}^2\right] - \left[2r \cdot \sum \begin{pmatrix}\text{SURFACE AREA}\\ \text{OF EACH S.U.}\end{pmatrix} \times \begin{pmatrix}\text{NO. MOOSE IN THE}\\ \text{CORRESPONDING S.U.}\end{pmatrix}\right] + \left[r^2 \cdot \sum \begin{pmatrix}\text{SURFACE AREA}\\ \text{OF EACH S.U.}\end{pmatrix}^2\right]}{n-1}$$

OR

$$s_\delta^2 = \frac{\sum_{i=1}^{n} y_i^2 - 2r \sum_{i=1}^{n} x_i y_i + r^2 \sum_{i=1}^{n} x_i^2}{n-1}$$

B. Calculation of the total population estimate ($\hat{T}_t$) and variance of the population estimate for the entire census area.

1. Total population estimate = Σ strata population estimates

$$\hat{T}_t = \hat{T}_H + \hat{T}_M + \hat{T}_L = (r_H \cdot A_H) + (r_M \cdot A_M) + (r_L \cdot A_L)$$

where H = high density stratum, M = medium, and L = low

2. Variance of the estimate of the number of moose in census area = Σ variance of the strata population estimates

$$V(\hat{T}_t) = V(\hat{T}_H) + V(\hat{T}_M) + V(\hat{T}_L) = [A_H^2 \cdot V(r_H)] + [A_M^2 \cdot V(r_M)] + [A_L^2 \cdot V(r_L)]$$

C. Calculation of the confidence interval (CI) for the total population estimate of the census area.

1. CI = Total population estimate ± ($t_{n-1\ d.f.}$) $\sqrt{\text{variance of the total population estimate}}$

$$CI = \hat{T}_t \pm t_{n-1}\sqrt{V(\hat{T}_t)}$$

where t is the Student's t value for a specified probability - 90%

2. Evaluation of the confidence interval for the total population estimate of the census area.

a. $$\frac{(\text{total population estimate}) - (\text{lower end of C.I.})}{\text{Total population estimate}} = \text{\% of population estimate}$$

$$\frac{\hat{T}_t - CI_L}{\hat{T}_t} = \text{\% of population estimate}$$

b. We recommend striving for precision equal to or greater than a 90% C.I. which has outer limits of ±20% of the estimate population. Bare in mind that precision greater than this will rarely be obtainable because of limitations on time and money.

Sightability Correction Factor will up this estimate.

VIII. Optimum allocation of search effort

A. Optimum allocation of search effort (or how to get the most data/dollar) is the process of distributing the available survey effort in the most efficient manner, so as to minimize the variance of the mean estimate of moose density per stratum.

1. Initial allocation of search intensity

a. Upon completion of stratification it is necessary to estimate the surface area in each stratum before calculating the allocation of sample units among the strata

1) the easiest way to accomplish this is by counting square mile sections and estimating partial sections from the composite topographic map of the census area.

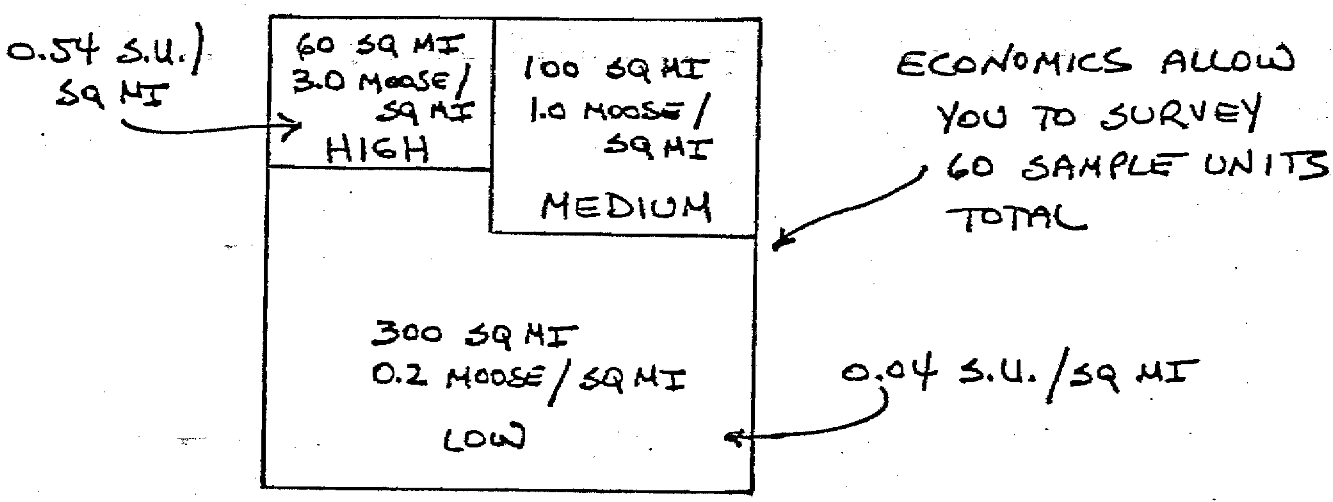
b. Once the area of each stratum has been estimated it is then possible to calculate the initial allocation of search effort using the formula:

$$N_i = \frac{T\, n_i}{\sum_{j=1}^{n} n_j}$$

where,

N_i = number of sample units to be surveyed in a stratum
T = total number of sample units you can afford to survey
n_i = estimated number of moose in each stratum (estimated density x area)
n_j = estimated total number of moose in all strata

1) EXAMPLE



A_H = 60 sq. mi.; estimated high density = 3.0 moose/sq. mi.; n_H = 180 moose

A_H = 100 sq. mi.; estimated medium density = 1.0 moose/sq. mi.; n_M = 100 moose

A_L = 300 sq. mi.; estimated low density = 0.2 moose/sq. mi.; n_L = 60 moose

n_t = 340 moose

$N_H = \frac{60 \times 180}{340} = 32$ S.U.; $N_M = \frac{60 \times 100}{340} = 18$ S.U.; $N_L = \frac{60 \times 60}{340} = 11$ S.U.

2) The ratios above are only an approximation of the required sampling scheme within the census area. It is necessary to adjust the search effort per stratum as the census progresses in order to minimize variance.

2. Adjustment of the search effort between stratum is accomplished by calculating strata population estimates and variances as soon as enough sample units have been surveyed to allow these computations.
   a. The resulting variance estimates will allow the biologist to determine which strata have the largest variance and require the greatest proportion of remaining sampling effort.
   b. The process of reapportioning search effort is influenced by the rate that the census is progressing and the variation in observed moose density within strata.
      1) In order to maintain optimum allocation of search effort, reevaluation should be performed as frequently as deemed necessary.

IX. Precision of the estimate

A. No estimate of numbers of moose will be absolutely accurate. Several sources of error exist which always cause a discrepancy between the estimated and the true number of moose.
   1. Sampling error
      a. If the entire area were searched there would be no need for sample units and no sampling error would exist. However, we are conducting censuses in areas too large for total count procedures.

b. The mean density of moose found in the area sampled will always differ slightly from the true density, but it will approach the true density as the number of sample units increases.

2. Error in sightability estimate

a. We see less than 100% of the moose; therefore, a sightability correction factor must be estimated. The estimated SCF is not exact.

3. Errors in calculations

a. The area of each stratum cannot be measured exactly, thus an error of several percent could result from this source alone.

B. How accurate is the estimate? Since you can never know the true density or number of moose you cannot directly evaluate the quality of the estimates.

1. However, a probability that the true value is within a certain range of the estimated value can be assigned. This is the Confidence Interval.

a) as the confidence interval decreases at a particular probability, you have reason to develop increasing confidence in the accuracy of the estimate.

C. Ways to improve accuracy

1. Choose a SU area which minimizes variation between SU.

2. Stratify accurately

3. Maintain a search effort which provides a high sightability

4. Spend the effort to make a good estimate of sightability of moose
5. Practice survey procedures prior to the census
6. Fly when the weather and snow conditions are acceptable so as to reduce variation in sightability of moose

X. Experience and currency of pilots and observers

A. All personnel piloting or observing should be trained in the methods to insure consistency among survey teams.

1. Biologist and pilots should practice survey methods prior to the census so proper search effort and search pattern can be used from the first SU counted. Locating boundaries of SU requires a little practice. The pilot is primarily responsible for maintaining the flight path within the SU while searching. The pilot must be able to read 1:63000 scale maps on a very detailed basis.
2. Periodic breaks during the day will help reduce fatigue and maintain good counting efficiency. Take a short break every 2 hours or so if possible. A census requires that you are mentally sharp during the search of SU. Use the flight time between SU to relax in the plane (pilot should not relax too much).
3. The aircraft choice is a two-place plane with tandom seating.

Table 1. Classification of snow conditions for sightability of moose during aerial surveys.

Age of Snow	Coverage	Classification
Fresh	Complete	Good
	Some low vegetation showing	Moderate
	Bare or herbaceous vegetation ground showing	Poor
Moderate	Complete	Good
	Some low vegetation showing	Moderate
	Bare or herbaceous vegetation ground showing	Poor
Old	Complete	Moderate
	Some low vegetation showing	Poor
	Bare or herbaceous vegetation ground showing	Poor

Table ___.

SAMPLE UNIT SELECTION FORM

NO.	STRATUM			
	LOW	MEDIUM	HIGH	OTHER
1	___	___	___	___
2	___	___	___	___
3	___	___	___	___
4	___	___	___	___
5	___	___	___	___
6	___	___	___	___
ect				

Table 2. Time searched per square mile during surveys conducted between 1974 and 1979 in Interior Alaska.

Type of Survey	Mean min per mi sq (Range) Flats	Hills	Mtn. Foothills
Composition Counts[a] in Game Management Units			
20A	1.4(1-1.9)	-	1.9(1.5-2.2)
20B	-	2.1(1.5-3.0)[c]	-
13	0.8	-	1.2
Present Study			
Transect/Contour	-[b]	4.9(2.1-14.8)	4.9(1.5-11.3)
Intensive	12.9(5.3-21.5)	9.7(4.5-26.2)	11.0(2.9-22.6)

[a] These are examples of typical surveys conducted by the Alaska Department of Fish and Game. Transects were used over flat terrain while contour flights were flown in irregular terrain.

[b] The actual time spent searching was not recorded; however, the time per mi^2 was theoretically 1.6 min per mi^2 plus the time spent circling moose to identify sex and age.

[c] Values are mean min/mi^2 for 10 surveys during November and December of 1974-1975.

Table 9. The influence of snow on activity, habitat selected and search intensity.

Habitat Selected	Percent Radio-collared Moose Seen During Quadrat Searches (no. of moose): Transect/Contour Search: Standing: Good	Mod	Poor	Lying: Good	Mod	Poor	Intensive Search: Standing: Good	Mod	Poor	Lying: Good	Mod	Poor
Nonspruce[a]	94 (32)	93 (14)	85 (13)	82 (44)	78 (27)	44 (9)	100 (31)	100 (31)	100 (13)	98 (40)	93 (27)	100 (9)
Spruce[b]	70 (10)	50 (8)	0 (1)	55 (20)	17 (12)	0 (4)	78 (9)	88 (8)	0 (1)	90 (21)	83 (12)	75 (4)

[a] Includes herbaceous, low shrub, tall shrub, deciduous forest and larch.

[b] Includes spruce forest and sparse spruce forest.

APPENDIX TABLE II. Cumulative Student's t distribution. The body of the table contains values of Student's t; n is the number of degrees of freedom.

Probabilities for confidence intervals

CUMULATIVE PROBABILITY BETWEEN $+t$ AND $-t$

n	.1	.2	.3	.4	.5	.6	.7	.8	.9	.95	.98	.99	.999
1	.158	.325	.510	.727	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657	636.619
2	.142	.289	.445	.617	.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	31.598
3	.137	.277	.424	.584	.765	.978	1.250	1.638	2.353	3.182	4.541	5.841	12.941
4	.134	.271	.414	.569	.741	.941	1.190	1.533	2.132	2.776	3.747	4.604	8.610
5	.132	.267	.408	.559	.727	.920	1.156	1.476	2.015	2.571	3.365	4.032	6.859
6	.131	.265	.404	.553	.718	.906	1.134	1.440	1.943	2.447	3.143	3.707	5.959
7	.130	.263	.402	.549	.711	.896	1.119	1.415	1.895	2.365	2.998	3.499	5.405
8	.130	.262	.399	.546	.706	.889	1.108	1.397	1.860	2.306	2.896	3.355	5.041
9	.129	.261	.398	.543	.703	.883	1.100	1.383	1.833	2.262	2.821	3.250	4.781
10	.129	.260	.397	.542	.700	.879	1.093	1.372	1.812	2.228	2.764	3.169	4.587
11	.129	.260	.396	.540	.697	.876	1.088	1.363	1.796	2.201	2.718	3.106	4.437
12	.128	.259	.395	.539	.695	.873	1.083	1.356	1.782	2.179	2.681	3.055	4.318
13	.128	.259	.394	.538	.694	.870	1.079	1.350	1.771	2.160	2.650	3.012	4.221
14	.128	.258	.393	.537	.692	.868	1.076	1.345	1.761	2.145	2.624	2.977	4.140
15	.128	.258	.393	.536	.691	.866	1.074	1.341	1.753	2.131	2.602	2.947	4.073
16	.128	.258	.392	.535	.690	.865	1.071	1.337	1.746	2.120	2.583	2.921	4.015
17	.128	.257	.392	.534	.689	.863	1.069	1.333	1.740	2.110	2.567	2.898	3.965
18	.127	.257	.392	.534	.688	.862	1.067	1.330	1.734	2.101	2.552	2.878	3.922
19	.127	.257	.391	.533	.688	.861	1.066	1.328	1.729	2.093	2.539	2.861	3.883
20	.127	.257	.391	.533	.687	.860	1.064	1.325	1.725	2.086	2.528	2.845	3.850
21	.127	.257	.391	.532	.686	.859	1.063	1.323	1.721	2.080	2.518	2.831	3.819
22	.127	.256	.390	.532	.686	.858	1.061	1.321	1.717	2.074	2.508	2.819	3.792
23	.127	.256	.390	.532	.685	.858	1.060	1.319	1.714	2.069	2.500	2.807	3.767
24	.127	.256	.390	.531	.685	.857	1.059	1.318	1.711	2.064	2.492	2.797	3.745
25	.127	.256	.390	.531	.684	.856	1.058	1.316	1.708	2.060	2.485	2.787	3.725
26	.127	.256	.390	.531	.684	.856	1.058	1.315	1.706	2.056	2.479	2.779	3.707
27	.127	.256	.389	.531	.684	.855	1.057	1.314	1.703	2.052	2.473	2.771	3.690
28	.127	.256	.389	.530	.683	.855	1.056	1.313	1.701	2.048	2.467	2.763	3.674
29	.127	.256	.389	.530	.683	.854	1.055	1.311	1.699	2.045	2.462	2.756	3.659
30	.127	.256	.389	.530	.683	.854	1.055	1.310	1.697	2.042	2.457	2.750	3.646
40	.126	.255	.388	.529	.681	.851	1.050	1.303	1.684	2.021	2.423	2.704	3.551
60	.126	.254	.387	.527	.679	.848	1.046	1.296	1.671	2.000	2.390	2.660	3.460
120	.126	.254	.386	.526	.677	.845	1.041	1.289	1.658	1.980	2.358	2.617	3.373
∞	.126	.253	.385	.524	.674	.842	1.036	1.282	1.645	1.960	2.326	2.576	3.291
"2-sided"	.9	.8	.7	.6	.5	.4	.3	.2	.1	.05	.02	.01	.001
"1-sided"	.45	.40	.35	.30	.25	.20	.15	.10	.05	.025	.010	.005	.0005

Significance probabilities for t-test

Appendix Table II is adapted from Table III of Fisher and Yates, *Statistical Tables for Biological, Agricultural, and Medical Research*, published by Oliver & Boyd, Ltd., Edinburgh, by permission of the authors and publishers.

Table A.1

Ten Thousand Random Digits

	00–04	05–09	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49
00	88758	66605	33843	43623	62774	25517	09560	41880	85126	60755
01	35661	42832	16240	77410	20686	26656	59698	86241	13152	49187
02	26335	03771	46115	88133	40721	06787	95962	60841	91788	86386
03	60826	74718	56527	29508	91975	13695	25215	72237	06337	73439
04	95044	99896	13763	31764	93970	60987	14692	71039	34165	21297
05	83746	47694	06143	42741	38338	97694	69300	99864	19641	15083
06	27998	42562	63402	10056	81668	48744	08400	83124	19896	18805
07	82685	32323	74625	14510	85927	28017	80588	14756	54937	76379
08	18386	13862	10988	04197	18770	72757	71418	81133	69503	44037
09	21717	13141	22707	68165	58440	19187	08421	23872	03036	34208
10	18446	83052	31842	08634	11887	86070	08464	20565	74390	36541
11	66027	75177	47398	66423	70160	16232	67343	36205	50036	59411
12	51420	96779	54309	87456	78967	79638	68869	49062	02196	55109
13	27045	62626	73159	91149	96509	44204	92237	29969	49315	11804
14	13094	17725	14103	00067	68843	63565	93578	24756	10814	15185
15	92382	62518	17752	53163	63852	44840	02592	88572	03107	90169
16	16215	50809	49326	77232	90155	69955	93892	70445	00906	57002
17	09342	14528	64727	71403	84156	34083	35613	35670	10549	07468
18	38148	79001	03509	79424	39625	73315	18811	86230	99682	82896
19	23689	19997	72382	15247	80205	58090	43804	94548	82693	22799
20	25407	37726	73099	51057	68733	75768	77991	72641	95386	70138
21	25349	69456	19693	85568	93876	18661	69018	10332	83137	88257
22	02322	77491	56095	03055	37738	18216	81781	32245	84081	18436
23	15072	33261	99219	43307	39239	79712	94753	41450	30944	53912
24	27002	31036	85278	74547	84809	36252	09373	69471	15606	77209
25	66181	83316	40386	54316	29505	86032	34563	93204	72973	90760
26	09779	01822	45537	13128	51128	82703	75350	25179	86104	40638
27	10791	07706	87481	26107	24857	27805	42710	63471	08804	23455
28	74833	55767	31312	76611	67389	04691	39687	13596	88730	86850
29	17583	24038	83701	28570	63561	00098	60784	76098	84217	34997
30	45601	46977	39325	09286	41133	34031	94867	11849	75171	57682
31	60683	33112	65995	64203	18070	65437	13624	90896	80945	71987
32	29956	81169	18877	15296	94368	16317	34239	03643	66081	12242
33	91713	84235	75296	69875	82414	05197	66596	13083	46278	73498
34	85704	86588	82837	67822	95963	83021	90732	32661	64751	83903
35	17921	26111	35373	86494	48266	01888	65735	05315	79328	13367
36	13929	71341	80488	89827	48277	07229	71953	16128	65074	28782
37	03248	18880	21667	01311	61806	80201	47889	83052	31029	06023
38	50583	17972	12690	00452	93766	16414	01212	27964	02766	28786
39	10636	46975	09449	45986	34672	46916	63881	83117	53947	95218
40	43896	41278	42205	10425	66560	59967	90139	73563	29875	79033
41	76714	80963	74907	16890	15492	27489	06067	22287	19760	13056
42	22393	46719	02083	62428	45177	57562	49243	31748	64278	05731
43	70942	92042	22776	47761	13503	16037	30875	80754	47491	96012
44	92011	60326	86346	26738	01983	04186	41388	03848	78354	14964
45	66456	00126	45685	67607	70796	04889	98128	13599	93710	23974
46	96292	44348	20898	02227	76512	53185	03057	61375	10760	26889
47	19680	07146	53951	10935	23333	76233	13706	20502	60405	09745
48	67347	51442	24536	60151	05498	64678	87569	65066	17790	55413
49	95888	59255	06898	99137	50871	81265	42223	83303	48694	81953

Table A.1 (Continued)

Ten Thousand Random Digits

	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–99
00	70896	44520	64720	49898	78088	76740	47460	83150	78905	59870
01	56809	42909	25853	47624	29486	14196	75841	00393	42390	24847
02	66109	84775	07515	49949	61482	91836	48126	80778	21302	24975
03	18071	36263	14053	52526	44347	04923	68100	57805	19521	15345
04	98732	15120	91754	12657	74675	78500	01247	49719	47635	55514
05	36075	83967	22268	77971	31169	68584	21336	72541	66959	39708
06	04110	45061	78062	18911	27855	09419	56459	00695	70323	04538
07	75658	58509	24479	10202	13150	95946	55087	38398	18718	95561
08	87403	19142	27208	35149	34889	27003	14181	44813	17784	41036
09	00005	52142	65021	64438	69610	12154	98422	65320	79996	01935
10	43674	47103	48614	70823	78252	82403	93424	05236	54588	27757
11	68597	68874	35567	98463	99671	05634	81533	47406	17228	41155
12	91874	70208	06308	40719	02772	69589	79936	07514	44950	35190
13	73854	19470	53014	29375	62256	77488	74388	53949	49607	19816
14	65926	34117	55344	68155	38099	56009	03513	05926	35584	42328
15	40005	35246	49440	40295	44390	83043	26090	80201	02934	49260
16	46686	29890	14821	69783	34733	11803	64845	32065	14527	38702
17	02717	61518	39583	72863	50707	96115	07416	05011	36756	61065
18	17048	22281	35573	28944	96889	51823	57268	03866	27658	91950
19	75304	53248	42151	93928	17343	88322	28683	11252	10355	65175
20	97844	62947	62230	30500	92816	85232	27222	91701	11057	83257
21	07611	71163	82212	20653	21499	51496	40715	78952	33029	61207
22	47744	04603	44522	62783	39347	72310	41460	31052	40814	91297
23	54293	43576	88116	67416	34908	15238	40561	73940	56850	31078
24	67556	93979	73363	00300	11217	74405	18937	79000	68834	48307
25	86581	73041	95809	73986	49408	53316	90841	73808	53421	82315
26	28020	86282	83365	76600	11261	74354	20968	60770	12141	09539
27	42578	32471	37840	30872	75074	79027	57813	62831	54715	26693
28	47290	15997	86163	10571	81911	92124	92971	80860	41012	58666
29	24856	63911	13221	77028	06573	33667	30732	47280	12926	67276
30	16352	24836	60799	76281	83402	44709	78930	82969	84468	36910
31	89060	79852	97854	28324	39638	86936	06702	74301	39873	19496
32	07637	30412	04921	26471	09605	07355	20466	49793	40539	21077
33	37711	47786	37468	31963	16908	50283	80884	08252	72655	58926
34	82994	53232	58202	73318	62471	49650	15888	73370	98748	69181
35	31722	67288	12110	04776	15168	68862	92347	90789	66961	04162
36	93819	78050	19364	38037	25706	90879	05215	00260	14426	88207
37	65557	24496	04713	23688	26623	41356	47049	60676	72236	01214
38	88001	91382	05129	36041	10257	55558	89979	58061	28957	10701
39	96648	70303	18191	62404	26558	92804	15415	02865	52449	78509
40	04118	51573	59356	02426	35010	37104	98316	44602	96478	08433
41	19317	27753	39431	26996	04465	69695	61374	06317	42225	62025
42	37182	91221	17307	68507	85725	81898	22588	22241	80337	89033
43	82990	03607	29560	60413	59743	75000	03806	13741	79671	25416
44	97294	21991	11217	98087	79124	52275	31088	32085	23089	21498
45	86771	69504	13345	42544	59616	07867	78717	82840	74669	21515
46	26046	55559	12200	95106	56496	76662	44880	89457	84209	01332
47	39689	05999	92290	79024	70271	93352	90272	94495	26842	51477
48	83265	89573	01437	43786	52986	49041	17952	35035	88985	84671
49	15128	35791	11296	45319	06330	82027	90808	54351	43091	30387

TABL[illegible] (C[illegible]ed)

TEN THOUSAND RANDOM DIGITS

	00–04	05–09	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49
50	54441	64681	93190	00993	62130	44484	46293	60717	50239	76319
51	08573	52937	84274	95106	89117	65849	41356	65549	78787	50442
52	81067	68052	14270	19718	88499	63303	13533	91882	51136	60828
53	39737	58891	75278	98046	52284	40164	72442	77824	72900	14886
54	34958	76090	08827	61623	31114	86952	83645	91786	29633	78294
55	61417	72424	92626	71952	69709	81259	58472	43409	84454	88648
56	99187	14149	57474	32268	85424	90378	34682	47606	89295	02420
57	13130	13064	36485	48133	35319	05720	76317	70953	50823	06793
58	65563	11831	82402	46929	91446	72037	17205	89600	59084	55718
59	28737	49502	06060	52100	43704	50839	22538	56768	83467	19313
60	50353	74022	59767	49927	45882	74099	18758	57510	58560	07050
61	65208	96466	29917	22862	69972	35178	32911	08172	06277	62795
62	21323	38148	26696	81741	25131	20087	67452	19670	35898	50636
63	67875	29831	59330	46570	69768	36671	01031	95995	68417	68665
64	82631	26260	86554	31881	70512	37899	38851	40568	54284	24056
65	91989	39633	59039	12526	37730	68848	71399	28513	69018	10289
66	12950	31418	93425	69756	34036	55097	97241	92480	49745	42461
67	00328	27427	95474	97217	05034	26676	49629	13594	50525	13485
68	63986	16698	82804	04524	39919	32381	67488	05223	89537	59490
69	55775	75005	57912	20977	35722	51931	89565	77579	93085	06467
70	24761	56877	56357	78809	40748	69727	56652	12462	40528	75269
71	43820	80926	26795	57553	28319	25376	51795	26123	51102	89853
72	66669	02880	02987	33615	54206	20013	75872	88678	17726	60640
73	49944	66725	19779	50416	42800	71733	82052	28504	15593	51799
74	71003	87598	61296	95019	21568	86134	66096	65403	47166	78638
75	52715	04593	69484	93411	38046	13000	04293	60830	03914	75357
76	21998	31729	89963	11573	49442	69467	40265	56066	36024	25705
77	58970	96827	18377	31564	23555	86338	79250	43168	96929	97732
78	67592	59149	42554	42719	13553	48560	81167	10747	92552	19867
79	18298	18429	09357	96436	11237	88039	81020	00428	75731	37779
80	88420	28841	42628	84647	59024	52032	31251	72017	43875	48320
81	07627	88424	23381	29680	14027	75905	27037	22113	77873	78711
82	37917	93581	04979	21041	95252	62450	05937	81670	44894	47262
83	14783	95119	68464	08726	74818	91700	05961	23554	74649	50540
84	05378	32640	64562	15303	13168	23189	88198	63617	58566	56047
85	19640	96709	22047	07825	40583	99500	39989	96593	32254	37158
86	20514	11081	51131	56469	33947	77703	35679	45774	06776	67062
87	96763	56249	81243	62416	84451	14696	38195	70435	45948	67690
88	49439	61075	31558	59740	52759	55323	95226	01385	20158	54054
89	16294	50548	71317	32168	86071	47314	65393	56367	46910	51269
90	31381	94301	79273	32843	05862	36211	93960	00671	67631	23952
91	98032	87203	03227	66021	99666	98368	39222	36056	81992	20121
92	48700	31826	94774	11366	81391	33602	69608	84119	93204	26825
93	68692	66849	29366	77540	14978	06508	10824	65416	23629	63029
94	19047	10784	19607	20296	31804	72984	60060	50353	23260	58909
95	82867	69266	50733	62630	00956	61500	89913	30049	82321	62367
96	26528	28928	52600	72997	80943	04084	86662	90025	14360	64867
97	51166	00607	49962	30724	81707	14548	25844	47336	57492	02207
98	97245	15440	55182	15368	85136	90869	33712	95152	50973	98658
99	54998	88830	95639	45104	72676	28220	82576	57381	34438	24565

SOURCE: Prepared by Fred Gruenberger, Numerical Analysis Laboratory, University of Wisconsin, Madison, Wis., 1952.

TEN THOUSAND RANDOM DIGITS

	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–99
50	58649	85086	16502	97541	76611	94229	34987	86718	87208	05426
51	97306	52449	55596	66739	36525	97563	29469	31235	79276	10831
52	09942	79344	78160	11015	55777	22047	57615	15717	86239	36578
53	83842	28631	74893	47911	92170	38181	30416	54860	44120	73031
54	73778	30395	20163	76111	13712	33449	99224	18206	51418	70006
55	88381	56550	47467	59663	61117	39716	32927	06168	06217	45477
56	31044	21404	15968	21357	30772	81482	38807	67231	84283	63552
57	00909	63837	91328	81106	11740	50193	86806	21931	18054	49601
58	69882	37028	41732	37425	80832	03320	20690	32653	90145	03029
59	26059	78324	22501	73825	16927	31545	15695	74216	98372	28547
60	38573	98078	38982	33078	93524	45606	53463	20391	81637	37269
61	70624	00063	81455	16924	12848	23801	55481	78978	26795	10553
62	49806	23976	05640	29804	38988	25024	76951	02341	63219	75864
63	05461	67523	48316	14613	08541	35231	38312	14969	67279	50502
64	76582	62153	53801	51219	30424	32599	49099	83959	68408	20147
65	16660	80470	75062	75588	24384	27874	20018	11428	32265	07692
66	60166	42424	97470	88451	81270	80070	72959	26220	59939	31127
67	28953	03272	31460	41691	57736	72052	22762	96323	27616	53123
68	47536	86439	95210	96386	38704	15484	07426	70675	06888	81203
69	73457	26657	36983	72410	30244	97711	25652	09373	66218	64077
70	11190	66193	66287	09116	48140	37669	02932	50799	17255	06181
71	57062	78964	44455	14036	36098	40773	11688	33150	07459	36127
72	99624	67254	67302	18991	97687	54099	94884	42283	63258	50651
73	97521	83669	85968	16135	30133	51312	17831	75016	80278	68953
74	40273	04838	13661	64757	17461	78085	60094	27010	80945	66439
75	57260	06176	49963	29760	69546	61336	39429	41985	18572	98128
76	03451	47098	63495	71227	79304	29753	99131	18419	71791	81515
77	62331	20492	15393	84270	24396	32962	21632	92965	38670	44923
78	32290	51079	06512	38806	93327	80086	19088	59887	98416	24918
79	28014	80428	92853	31333	32648	16734	43418	90124	15086	48444
80	18950	16091	29543	65817	07002	73115	94115	20271	50250	25061
81	17403	69503	01866	13049	07263	13039	83844	80143	39048	62654
82	27999	50489	66613	21843	71746	65868	16208	46781	93402	12323
83	87076	53174	12165	84495	47947	60706	64034	31635	65169	93070
84	89044	45974	14524	46906	26052	51851	84197	61694	57429	63395
85	98048	64400	24705	75711	36232	57624	41424	77366	52790	84705
86	09345	12956	49770	80311	32319	48238	16952	92088	51222	82865
87	07086	77628	76195	47584	62411	40397	71857	54823	26536	56792
88	93128	25657	46872	11206	06831	87944	97914	64670	45760	34353
89	85137	70964	29947	27795	25547	37682	96105	26848	09389	64326
90	32798	39024	13814	98546	46585	84108	74603	94812	73968	68766
91	62496	26371	89880	52078	47781	95260	83464	65942	91761	53727
92	62707	81825	40987	97656	89714	52177	23778	07482	91678	40128
93	05500	28982	86124	19554	80818	94935	61924	31828	79369	23507
94	79476	31445	59498	85132	24582	26024	24002	63718	79164	43556
95	10653	29954	97568	91541	33139	84525	72271	02546	64818	14381
96	30524	06495	00886	40666	68574	49574	19705	16429	90981	08103
97	69050	22019	74066	14500	14506	06423	38332	34191	82663	85323
98	27908	78802	63446	07674	98871	63831	72419	42705	26513	19883
99	64520	16618	47409	19574	78136	46047	01277	79146	95759	36781

Table 12. Tanana Flats sample data and associated estimates.

Sample Unit	Stratum: Low Moose (no.)	Low Area (mi^2)	Medium Moose (no.)	Medium Area (mi^2)	High Moose (no.)	High Area (mi^2)
1	7	22.1	3	8.2	21	13.6
2	4	35.0	13	14.3	27	20.6
3	0	20.1	4	12.1	2	6.2
4	4	29.6	0	14.4	15	10.8
5	2	18.3	6	9.6	25	16.0
6			11	27.7	24	10.8
7			5	16.4		
8			5	16.2		
9			6	21.1		
10			4	10.4		
Sample Total	17	125.1	57	150.4	114	78.0

Estimates	Low	Medium	High
Moose/mi^2	0.14	0.38	1.46
Variance of moose/mi^2	0.002	0.010	0.018
Total moose	156	526	430
Variance of total moose	2617	19,265	1556

Table 13. Foothills East sample data and associated esti

Sample Unit	Stratum: Low Moose (no.)	Low Area (mi^2)	Medium Moose (no.)	Medium Area (mi^2)	Hi Moose (no.)
1	8	9.9	14	13.8	29
2	2	13.5	15	14.2	
3	0	9.4	4	10.2	
4	14	19.6			
5	0	14.7			
6	2	17.0			
Sample Totals	26	84.1	33	38.2	29

Estimates	Low	Medium	Hi
Moose/mi^2	0.31	0.86	1.7
Variance of moose/mi^2	0.019	0.022	0.
Total moose	175	93	29
Variance of total moose	6,087	257	0

Table 14. Foothills West sample data and associated estimates.

Sample Unit	Stratum: Low Moose (no.)	Low Area (mi^2)	Medium Moose (no.)	Medium Area (mi^2)	High Moose (no.)	High Area (mi^2)
1	14	14.1	16	19.1	96	12.3
2	13	21.5	3	12.3	63	11.4
3	18	18.7	9	26.3	40	13.1
4	7	13.9	20	22.4	28	19.1
5	4	9.3	20	11.6	1	7.3
6	2	20.1	14	13.7	17	10.0
7			3	15.2	41	11.9
8			26	16.3		
9			13	18.7		
10			17	16.7		
11			4	10.8		
Sample Totals	58	97.6	145	183.1	286	85.1

Estimates	Low	Medium	High
Moose/mi^2	0.59	0.79	3.36
Variance of moose/mi^2	0.019	0.016	0.545
Total moose	261	577	655
Variance of total moose	3,678	8,503	21,366

MOOSE CENSUS SURVEY FORM

START TIME: ____

Sample Unit No. ________ Date __/__/__ STOP Time ________ Page __ of __

Location: map ________ Pilot/Observer ________

Location description ________

Habitat description ________

Weather: ________

SNOW Age: Fresh ____ Moderate ____ Old ____

Cover: Complete ____ Some low veg showing ____ Distracting amounts of bare ground showing ____ Snow on trees and shrubs ____

LIGHT Bright ____ Flat ____

INTENSITY High ____ Med. ____ Low ____

Type of Survey: / / Transect / / Contour / / Intensive

Time of Search (min): Contour ____ Intensive ____ (min:sec)

Remarks ________

	Agg. No.	BULLS/activ. yrlg	med	lge	COWS/activ. W/O calf	W/1 calf	W/2 calf		Unident	Total Moose	HABITAT
	1										H LS TS D SS S L
	2										H LS TS D SS S L
	3										H LS TS D SS S L
	4										H LS TS D SS S L
	5										H LS TS D SS S L
	6										H LS TS D SS S L
	7										H LS TS D SS S L
	8										H LS TS D SS S L
	9										H LS TS D SS S L
	10										H LS TS D SS S L
	11										H LS TS D SS S L
	12										H LS TS D SS S L

Appendix I. Form used for recording sightability during quadrat searches.

Quadrat No. 352 High Date 11 / 16 / 78 START Time ________ Page 1 of 1

Location: map quadrat ________ Pilot/Observer HAGGLAND/DUBOIS

Location description South bank of Tanana River opposite Ellsworth

Habitat description low shrub dominated Tren

(Tren)

Weather: clear, +3°F, 5-8 mph

SNOW Age: Fresh ____ Moderate ✓ Old ____ (Good)

Cover: Complete ✓ Some low veg showing ____ Distracting amounts of bare ground showing ____ Snow on trees and shrubs ____

LIGHT Bright ✓ Flat ____

INTENSITY High ____ Med. ✓ Low ____

Type of Survey: /✓/ Transcect 40 min. / / Contour / / Intensive

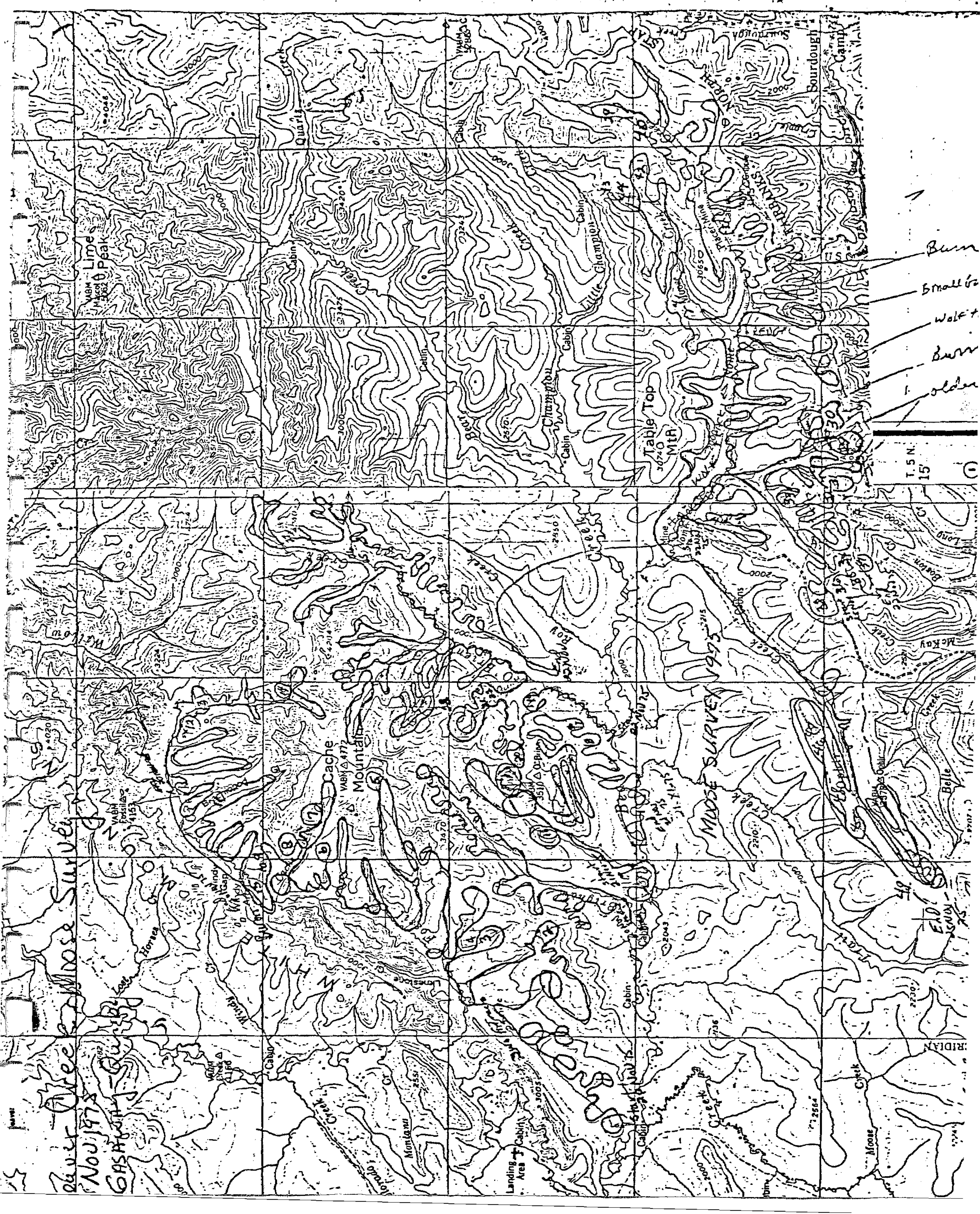
Time of Search (min): Contour ____ Intensive ____ (min:sec)

Indicated Air Speed 90 mph

Remarks START TIME – 10:14 DENSITY = 13.55 sq. mi. = 1.55 m/sq. mi.

STOP TIME – 10:54

Cr./Hill/Rdg.	Agg. No.	BULLS/activ. yrlg	med	lge	COWS/activ. W/O calf	W/1 calf	W/2 calf	W/ yrlg	Lone yrlg. act.	Total Moose	HABITAT Upper line = % available; Lower line = # moose in e; X = radio moose
	1				3/L					3	H (LS) (TS) D SS S L (herbaceous, low shrub, tall shrub, deciduous, sparse spruce, spruce, lowland)
	2					1/L				2	H (LS) TS D SS S L
	3					1/L				2	H (LS) (TS) D SS S L
	4					1/L				2	H (LS) TS D SS S L
	5						1/L			3	H (LS) TS D SS S L
	6	1/L								1	H (LS) TS D SS S (L)
	7				1/L					1	H (LS) (TS) D (SS) S L
	8					1/L				2	H (LS) TS D SS S L
	9					1/L				2	H (LS) (TS) D SS S L
	10						1/L			3	H (LS) TS D SS S (L)
	11										H LS TS D SS S L
	12										H LS TS D SS S L



Lime Peak
Table Top Mtn
Cache Mountain
Champion
Little Champion
Sourdough Camp
Moose Survey 1995
Burn