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MOOSE RESEARCH CENTER REPORT

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Volume XIV

Progress Report

Federal Aid in Wildlife Restoration

Project W-22-2, Job 1.28R and 1.31R

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PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: None

Project No: W-22-2

Project Title: Big Game Investigations

Job No.: 1.28R

Job Title: Moose Nutrition and  
Physiology Studies

Period Covered: 1 July 1982 through 30 June 1983

SUMMARY

No major studies were conducted during this report period because of a drop in personnel within the U.S. Fish and Wildlife Service, a cooperating agency. Long-term information on moose weights, and production and mortality of moose (Alces alces) within the Moose Research Center (MRC) enclosures was summarized. In addition, chronological information on moose histories for each pen was summarized and presented. These data represent a good information base for comparative purposes, and for long-term studies at the MRC.

Key words: moose, productivity, nutrition, mortality.

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## BACKGROUND

Digestive physiology studies were initiated in 1979 (Franzmann and Schwartz 1979) with moose (Alces alces) as part of the moose productivity and physiology project at the Moose Research Center (MRC) outlined by Franzmann et al. (1976). A major goal of these studies was to develop a carrying capacity model for moose. The program as outlined was a cooperative venture between the U.S. Fish and Wildlife Service-Denver Research Center, and the Alaska Department of Fish and Game. This cooperative venture worked quite well on earlier portions of the carrying capacity research. However, because of a general lack of support (budget and manpower) by the Denver Research Center, the local U.S. Fish and Wildlife Service biologist resigned. This resulted in a disruption of scheduled studies. Subsequently, bioenergetics of calves and protein requirement studies with calf moose in winter scheduled for this report were not conducted. Instead, we completed the analysis of nitrogen data collected in 1982, computerized serial weight data for the tame moose, and concentrated on other studies.

## OBJECTIVES

To establish baselines for blood, hair, and milk parameters in moose by sex, age, season, reproductive status, area, drug used,

excitability, and condition, and to evaluate their usefulness as indicators of nutritional and general condition status of moose.

To apply the above criteria to various moose populations of the State.

To estimate browse production and utilization and to quantitatively and qualitatively estimate consumption of plant materials by moose at the MRC.

To determine nutritional value and digestibility of the common moose forage species and to relate hair element monitoring to moose mineral metabolism.

To measure natality, mortality, and general condition of moose at the MRC.

To develop and test a formulated diet capable of meeting the essential nutrient requirements of captive moose.

To determine crude protein and gross energy requirements for various sex and age classes of captive moose on a seasonal basis.

To determine the effects of various levels of nutrient quality on blood parameters in captive moose.

To compare the ability of captive moose to digest and assimilate a formulative diet versus 4 major food items consumed by wild moose either singly or in combination during winter.

The goal is to obtain a more thorough and specific knowledge of how moose affect vegetation and how vegetation affects moose. The application of the indicator species concept to moose by gaining knowledge specific to moose physiology is an integral part of this goal.

## PROCEDURES

### Digestive Physiology of Moose

Procedures for digestion/metabolism studies tested under this job were outlined by Schwartz and Franzmann (1981).

## RESULTS AND DISCUSSION

Analysis of the protein digestion trials (Schwartz et al. 1983) has been summarized, and a manuscript is being drafted.

### Moose Weights

We are continuing to obtain biweekly weight data for the tame moose (Tables 1, 2). Weight data obtained from 1978 through March 1983 have been entered onto a computer tape. Digitized tracing (Fig. 1) for individual animal weights, by day, were constructed. Growth equations are currently being fitted to these data by the biometrics section and will be available for the next report.

### Productivity and Mortality of MRC Moose

Histories of individual moose through May 1983 are listed in Tables 3-7. We experienced some shifting of moose between pens and out of the pen system because of breaks in the fences.

Moose-days (Tables 8, 9) were tabulated for individual pens by season for adult and calf moose from 1974 through April 1983. This information will be used to aid in refinement of carrying capacity studies.

Chronological histories for each pen (Appendices A-D) were prepared to update historical information on moose productivity and natality at the MRC. These information summaries provide detailed data on every known moose within the MRC enclosures from the time of construction until June 1983. Because of information gaps, lack of sight records, unmarked moose, and undetected mortalities, the data listed were subject to interpretation based on our best knowledge of events within the MRC enclosures. These records provide the necessary baseline data for long-term studies or comparisons between enclosures.

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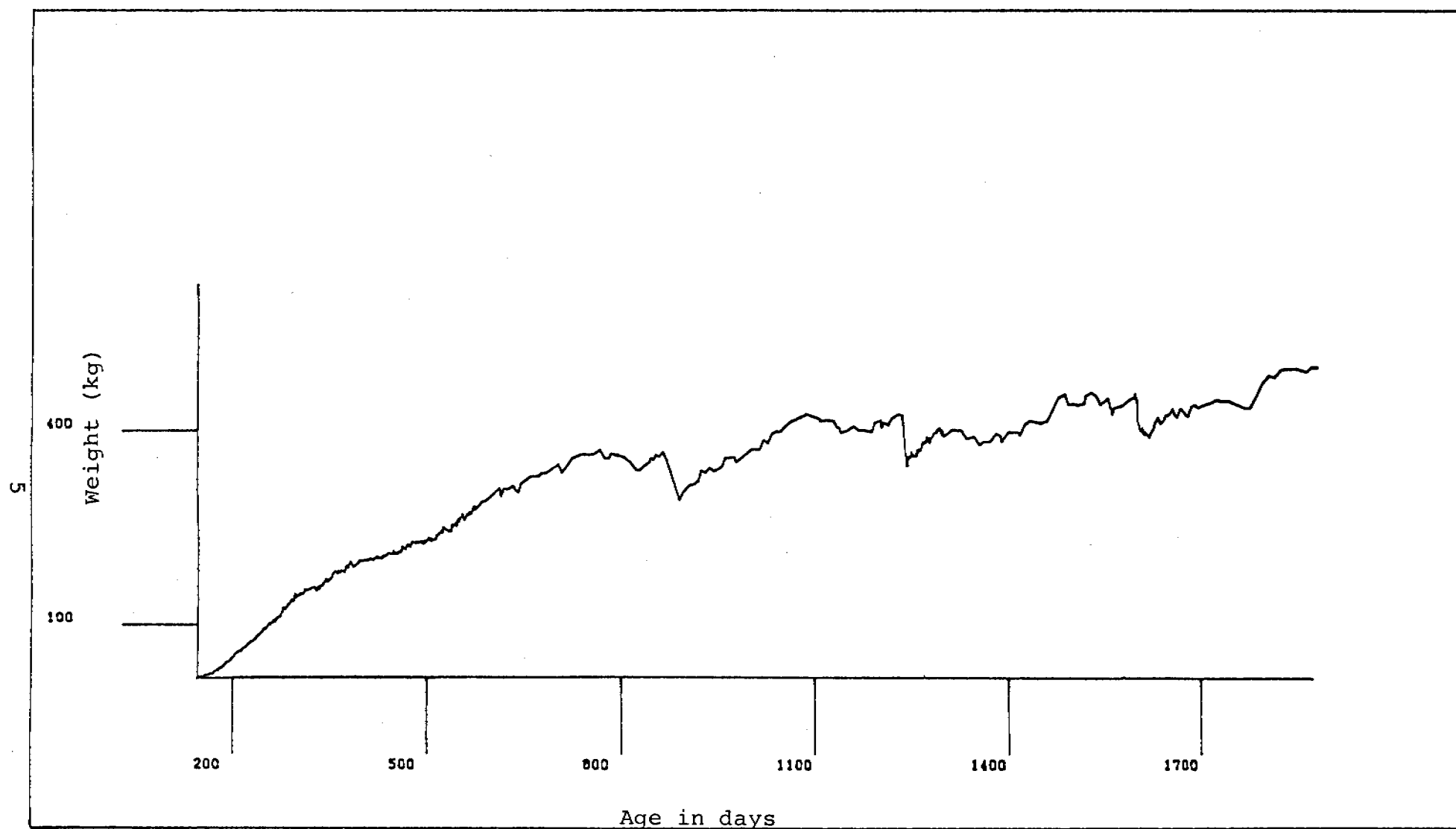


Fig. 1. Time tracing of moose weight for female Lucy, 1978-1982.

Table 1. Weights (kg) of 8 moose at Moose Research Center, June 1982 through June 1983.

Year	Individual moose								Comments
	Chief	Rodney	Lucy	Angel	Jezebel	Flo	Trixie	Oly	
1982									
6/1			398	391	386	440			
6/3			395	390	398	440			
6/4			393	387	389	438			
6/5						436			
6/6						436			
6/7						429			Wet
6/8			389	395	391	419			Flo weighed, water broke
6/10			395	387					Jez w/Joker, turned into big pen 6/6
6/11						382			Flo w/infection of uterus
6/13			401	397	393				Jez w/Joker, locked up 6/12
6/15	524		404	391	384	370	282	259	Flo still not eating
6/17			413	407	402				
6/18						360			Flo still not eating
6/22			420	410	401	342			Flo turned out
6/24	513	487					287	276	
6/25			410		409				
6/28				405	405				
6/30			416	416	403				
7/3			424	413	417				
7/6			422	422	412				
7/9			426	405	404				
7/11			429	436	420				Angel weighed after drink
7/14			433	431	419				
7/16	547	534							
7/17			424	433	428				Cows and calves released
7/21	561	538	420	421	422				Cows and calves locked in 7/23
7/22							318	297	
7/26			434	427	424				Cows and calves released 7/27
7/29				425	434				Cows and calves locked in
8/1			428	431	429				
8/5			422	434	430		333	314	Lucy lame left front foot
8/6	513	546							Chief weighed after big drink
8/8			423	441	442				Cows and calves released 8/9
8/13	587	555	437	437	451		337	320	Cows and calves locked in
8/18			440	449	444				Lucy putting weight on foot
8/23		587	435	441	461		350	328	
9/1	553								Chief better after not feeling well
									Jez and Joker released to big pen 8/30
9/4		602	441	465	466		356	331	Jez and Joker locked in
9/7	559						364	335	Ollie and Trixie locked in w/cows
9/14			444	460	460		372	353	Calves weaned to Pen 2
9/21			448	451	461		371	348	



Table 1. Continued.

Year	Individual moose								Comments
	Chief	Rodney	Lucy	Angel	Jezebel	Flo	Trixie	Oly	
9/24	505								
9/27			445	456	462		378	352	
10/8	482		446	449	456		370	346	
10/31	480								Bulls in big pen
11/2				449	440				
11/4			434		437		368	342	
11/8	493								
11/11	490		435	460			379		
11/14					448			347	
11/21			452	470	452		390	359	
11/22	506								
11/29	510								Chief w/abscess on right side of head
12/1	506		473	487	465		392	362	
12/11	492		485	491	479		402	373	Chief's abscess draining
12/20	513		482	488			400	371	
12/30	522		497	487			401	378	
1983									
1/9	532				493				
1/10			496	497			406		
1/13								384	
1/22	523		496	493	475		400	382	
2/1	517								
2/7	511		491	486				385	Chief shed right antler
2/14	519	534	498	497	480		411	387	Bulls have shed antlers
2/25	527	542	498	498					
2/26					493		416	394	
3/4	516	537		496	502				Chief has infected dewclaw
3/12	516	551	482	495	501		417	396	
4/6	524	538		488			415		
4/9					500				
4/11	524	538	462	483	492		411	397	
4/21	524	531	469	483	501		419	400	
5/2					507				Jezebel weighed wet
5/5	548	539	477	481	501		428	405	
5/13	558	543	482	481	494		431	410	
5/24	572	556	487	490	504		441		
5/27				474				410	Angel very agitated
5/29				425					Day after Angel gave birth
6/2				402					
6/4			503	407	506		447	422	

Table 1. Continued.

Year	Individual moose								Comments
	Chief	Rodney	Lucy	Angel	Jezebel	Flo	Trixie	Oly	
6/8	572				468				Morning after Jez gave birth
6/9			504	406	465		439		
6/10				410				428	Angel turned out with bulls
6/12		575		410	452				
6/15					442		400		Afternoon after Trixie gave birth
6/17			457		437		398	385	First postpartum weights for Lucy and Ollie
6/19	599	573	446	398	439		395	376	Trixie released after calf died
6/21					441			372	
6/23		437							
6/25		437			452			365	
6/26				405			382		
6/27	602								
6/29		438			459			363	

Table 2. Weights (kg) of 4 moose calves at Moose Research Center, May 1982 through June 1983.

Year	Individual moose			Fio's dead fetus	Comments
	Joker	Charlie	Newton		
1982					
5/19	15	--	--		Jezebel's calf, born between 1500 and 1700 hours; weighed at 1930 hours
5/20	15	14	--		Angel's calf born at 1342 hours; weighed at 1930 hours
5/21	17	14	14		Lucy's calf born before 0730; weighed at 0830 hours
5/22	18	15	15		
5/24	20	17	15		
5/25	21	19	16		
5/26	23	20	17		
5/28	26	23	20		
5/29	28	24	20		
5/31	28	24	22		Joker and Charlie scouring 5/30
6/1	28	25	23		
6/3	30	27	25		
6/4	31	28	27		
6/8	35	33	29	16	Born dead
6/10	--	35	30		Joker and Jezebel released into big pen 6/8
6/13	37	38	32		Joker and Jezebel locked up 6/12
6/15	39	40	34		
6/17	40	42	36		
6/22	47	45	38		
6/25	47	46	38		
6/28	52	48	40		
6/30	57	51	43		All calves eating MRC food
7/3	61	55	46		
7/6	64	59	47		
7/9	67	64	51		
7/11	70	65	52		Newton passing formed stools
7/17	79	75	56		Cows and calves released into big pen
7/21	82	--	61		Cows and calves locked up again 7/23
7/26	88	86	63		Cows and calves released 7/27
7/29	96	92	70		Cows and calves locked up 7/29
8/1	100	98	71		
8/5	106	104	76		
8/8	111	110	80		Cows and calves released 8/9
8/13	120	121	79		Cows and calves locked up 8/13
8/16	126	123	78		Newton lame in left front leg since 8/11
8/18	132	127	80		Newton still lame but better
8/23	140	133	76		Newton, lame, left shoulder joint enlarged
8/30	153	--	--		Joker released w/Jezebel
9/4	162	141	86		Charlie lame left front leg from since before 9/1

Table 2. Continued.

Year	Individual moose			Comments
	Joker	Charlie	Newton	
9/11	170	145	91	Joker and Jezebel locked up
9/14	173	150	91	Calves wearing radio collars <u>weaned</u> Pen 2
9/18	177	153	86	
9/21	177	156	87	Newton has discharge from nose
9/27	182	163	86	Newton scouring, discharging, limping, lump on jaw
10/2	190	166	--	Newton dead (possibly 9/30)
10/8	194	178		
11/2	209	185		
11/14	211	190		
11/21	215	197		
12/1	221	202		
12/10	226	204		
12/22	226	204		
12/30	236	215		
1983				
1/17	230	209		Calves put into pen w/other tame moose (weren't eating due to wolves in captivity)
1/22	226	205		
1/31	227	207		
2/7	230	206		
2/14	212			
2/25	--	220		
2/26	239	--		
3/4	240	223		
3/12	245	224		
4/6	248	229		
4/11	242	228		
4/21	245	233		
5/2	257	242		Calves wet
5/5	261	243		
5/13	260	247		
5/24	--	259		
5/25	269	--		
6/4	276	266		
6/12	291	269		
6/19	290	272		
6/26	294	286		

Table 3. Histories of Pen 1 moose at Kenai Moose Research Center (1 July 1982-30 June 1983).

Moose No.	Sex	Year of birth	Significant observations			No. of times observed	No. of times captured
			Date	Event	Remarks		
58 <sup>a</sup>	M	1970	5/11/83	Found dead	Winter mortality; last seen alive on 2/3/83	5	0
125 <sup>a</sup>	F	1966	7/25/83	Found dead	Last seen alive on 10/3/81 probably died during winter of 1981-82	0	0
8	M	1978	6/25/83	Observed	Only identification is 1 metal ear tag	12	0
R70-8	F	1968	6/19/83	Observed w/calf	Escaped from pen in 1981 but got back in between 6/15-7/21/82	8	0
37-38	F	1980-81	6/24/83	Observed w/calf	Trapped and radio-collared on 3/18/83	5	1
29-83	F	?	5/11/83	Trapped	Trapped and radio-collared on 5/11/83; probably same cow often seen when UC	1	1
UC <sup>b</sup>	F	1980-81	7/1/83	Observed	Three UC cows seen at same time	?	0
UC	F	1980-81	7/1/83	Observed	Three UC cows seen at same time	?	0
UC	F	?	7/1/83	Observed	Three UC cows seen at same time	?	0

<sup>a</sup> Moose no longer living in this pen.  
<sup>b</sup> UC = Uncollared.

Table 4. Histories of Pen 2 moose at Kenai Moose Research Center (1 July 1982-30 June 1983).

Moose No.	Sex	Year of birth	Date	Event	Significant observations	No. of times observed	No. of times captured
					Remarks		
33-83	F	?	5/11/83	Trapped; not processed	Trapped and radio-collared on 3/15/83	2	2
UC <sup>a</sup>	M	1981	12/9/82	Turned out of Pen 2	Small yearling with very small antlers	15-20	0
UC <sup>b</sup>	M	1979-80	5/11/83	Observed	Helicopter survey	3-5	0
UC	M	1981	5/11/83	Observed	Helicopter survey	4-7	0
UC	F	?	5/11/83	Observed	Helicopter survey	?	0
UC	F	?	5/11/83	Observed	Helicopter survey	?	0
UC	F	?	6/8/83	Observed w/calf	Probably one of the 3 UC cows seen during helicopter survey of 5/11/83	?	0
UC <sup>a</sup>	?	1982	10/2/83	Observed w/calf	Calf not seen after 10/2/82; assumed dead; no yearlings seen in 1983	2	0

<sup>a</sup> Moose no longer living in this pen.  
<sup>b</sup> UC = Uncollared.

Table 5. Histories of Pen 3 moose at Kenai Moose Research Center (1 July 1982-30 June 1983).

Moose No.	Sex	Year of birth	Significant observations			No. of times observed	No. of times captured
			Date	Event	Remarks		
5	M	1974	5/11/83	Observed	Helicopter survey	2	0
13 <sup>a</sup>	F	?	7/20/83	Found dead	Probably winter mortality; last seen alive 6/5/82	0	0
18	F	?	5/11/83	Observed	Helicopter survey	1	0
20	F	?	5/11/83	Observed	Helicopter survey	2	0
UC <sup>b</sup>	F	?	5/11/83	Observed	Helicopter survey	?	0
UC <sup>b</sup>	F	?	5/11/83	Observed	Helicopter survey	?	0
75(15) <sup>b</sup>	F	1969	6/7/82	Last sighted	Probably died or lost identification	?	0
17 <sup>b</sup>	F	?	10/1/81	Last sighted	Probably died or lost identification	?	0
UC <sup>c</sup>	M	1981-82	5/11/83	Observed	Helicopter survey	1	0
UC	M	1981-82	5/11/83	Observed	Helicopter survey	1	0

<sup>a</sup> Moose no longer living in this pen.

<sup>b</sup> Cows numbered 75(15) and 17 may be the UC cows seen on 5/11/83. One UC cow with notched ears was seen on 1/2/83, so it is certain that at least 1 previously tagged cow lost her identification.

<sup>c</sup> UC = Uncollared.

Table 6. Histories of Pen 4 moose at Kenai Moose Research Center (1 July 1982-30 June 1983).

Moose No.	Sex	Year of birth	Significant observations			No. of times observed	No. of times captured
			Date	Event	Remarks		
UC	F	?	5/11/83	Observed	Helicopter survey	?	0
UC	F	?	5/11/83	Observed	Helicopter survey	?	0
UC <sup>a</sup>	M	1979-80	12/5/81	Caught in trap; released	Assumed to have escaped from Pen 4 through 1-way gate	0	0

<sup>a</sup> A 1-way gate, which allows moose to leave Pen 4, was built in the southeast corner in 1981. It is not known how many moose have left Pen 4.



Table 7. Mortality within enclosures at Kenai Moose Research Center (1 July 1982-30 June 1983).<sup>a</sup>

Pen No.	Moose No.	Sex	Year of birth	Observation date	Remarks
1	58	M	1970	5/11/83	Found dead; last seen alive on 2/3/83; winter mortality
1	125	F	1966	7/25/82	Found dead; last seen alive on 10/3/81; probably died during winter 1981-82
2	UC	?	1982	10/2/82	Last sighting of a 1982 calf in Pen 2; assumed to have died. No yearlings seen in 1983
3	13	F	?	7/20/83	Found dead; last seen alive on 6/5/82; probably died during winter 1982-83

<sup>a</sup> Only 1 calf was known to have been born in the enclosures in 1982. Others may have been killed by predators or died of other causes without being sighted.

Table 8. Adult moose-days at MRC (1 May 1974-30 April 1983).

Season	Pen 1	Pen 2	Pen 3	Pen 4
5/1-9/30/74	1,005	1,680	1,017	2,295
10/1/74-4/30/75	1,130	2,130	1,357	3,061
5/1-9/30/75	918	1,224	1,071	1,560
10/1/75-4/30/76	1,278	1,582	1,491	2,040
5/1-9/30/76	1,215	1,224	1,071	1,530
10/1/76-4/30/77	1,393	1,577	1,484	1,968
5/1-9/30/77	918	1,423	1,530	1,086
10/1/77-4/30/78	1,242	1,283	2,453	2,120
5/1-9/30/78	765	1,083	1,284	1,215
10/1/78-4/30/79	1,379	1,033	848	1,637
5/1-9/30/79	1,071	552	918	475
10/1/79-4/30/80	1,270	729	1,409	639
5/1-9/30/80	918	1,132	880	705
10/1/80-4/30/81	1,211	1,432	1,098	1,327
5/1-9/30/81	1,071	735	1,076	1,219
10/1/81-4/30/82	1,395	1,052	1,666	1,180
5/1-9/30/82	1,316	1,071	1,224	673
10/1/82-4/30/83	1,666	1,341	1,696	848

Table 9. Calf moose-days at MRC (1 May 1974-30 April 1983).

Season	Pen 1	Pen 2	Pen 3	Pen 4
5/1-9/30/74	130	520	260	435
10/1/74-4/30/75	107	474	243	214
5/1-9/30/75	260	511	390	178
10/1/75-4/30/76	426	578	213	213
5/1-9/30/76	146	516	390	260
10/1/76-4/30/77	212	848	636	363
5/1-9/30/77	0	130	260	260
10/1/77-4/30/78	0	182	364	545
5/1-9/30/78	260	191	444	308
10/1/78-4/30/79	424	15	575	333
5/1-9/30/79	0	260	0	130
10/1/79-4/30/80	0	509	0	213
5/1-9/30/80	260	0	115	15
10/1/80-4/30/81	424	0	213	0
5/1-9/30/81	350	130	328	407
10/1/81-4/30/82	547	416	394	517
5/1-9/30/82	0	130	0	0
10/1/82-4/30/83	0	212	0	0

Appendix A. Chronological histories of moose in Pen 1 at Kenai Moose Research Center (January 1967-June 1983).

Moose Identification<sup>a</sup>

Status of Moose on Yearly Basis <sup>b</sup>	Number: 1		Number: 2 (R69-3)		Number: 3		Number: 4	
	Sex:	F	Sex:	F	Sex:	F	Sex:	F
	Year of birth:	1963/64	Year of birth:	1963	Year of birth:	1962	Year of birth:	1952
	Mother's Number:	?	Mother's Number:	?	Mother's Number:	?	Mother's Number:	?
1967	P-Jan.		P-Jan.		P-Jan.		P-Jan.	
1968	C-17 Jan., E to Pen 2, 4 Sep.		C-17 Jan., E to Pen 2, 4 Sep.		C-17 Jan.		C-18 Jan.	
1969					A		D-25 Apr.	
1970					A		F-29 Apr.	
1971					A			
1972					A			
1973					E to Pen 2, 30 Sep.			
1974-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: 5		Number: 6		Number: 8		Number: 9	
	Sex:	F	Sex:	F	Sex:	F	Sex:	F
	Year of birth:	?	Year of birth:	1957	Year of birth:	1967	Year of birth:	1962
	Mother's Number:	?	Mother's Number:	?	Mother's Number:	?	Mother's Number:	?
1967	P-Jan.		P-Jan.		B		P-Jan.	
1968	C-18 Jan., D-19 Jan.		C-18 Jan.		C-24 Jan., D-25 Jan., F-2 Feb.		C-24 Jan., E to Pen 2, 4 Sep.	
1969			A					
1970			A					
1971			A					
1972	F-5 Jun.		D-1 Apr., F-10 May					
1973								
1974-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: 10		Number: 43		Number: 40		Number: R70-8	
	Sex:	F	Sex:	M	Sex:	F	Sex:	F
	Year of birth:	1967	Year of birth:	1967	Year of birth:	1967	Year of birth:	1968
	Mother's Number:	9	Mother's Number:	?	Mother's Number:	4	Mother's Number:	1
1967	B				B			
1968	C-24 Jan.		IP from outside-7 Jun., C-7 Jun.		A		B	
1969	A		A		A		A	
1970	A		A		C-1 Sep.		C-10 Jul.	
1971	A		A		A		A	
1972	A		E to Pen 2, 15 Sep.		E to Pen 2, 12 Oct., IP from Pen 2, 1 Dec.		A	
1973	A		IP from Pen 2-7 Feb.		E to Pen 2, 30 Sep.		A	
1974	D-18 Sep., F-18 Sep.		A				A	
1975			A				A	
1976			A				A	
1977			A				A	

## Appendix A. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	10 F 1967 9	Number: Sex: Year of birth: Mother's Number:	43 M 1967 ?	Number: Sex: Year of birth: Mother's Number:	40 F 1967 4	Number: Sex: Year of birth: Mother's Number:	R70-8 F 1968 1
1978			A				A	
1979			D-31 Mar.				A	
1980							A	
1981							E to outside, 31 Jul.	
1982							1A from outside-30 Jun.	
1983							A	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC(45) ? 1968 1	Number: Sex: Year of birth: Mother's Number:	UC ? 1968 2	Number: Sex: Year of birth: Mother's Number:	35 M 1968 3	Number: Sex: Year of birth: Mother's Number:	69 F 1968 6
1967								
1968	B		B		B		B	
1969	E to Pen 2, 4 Sep.		E to Pen 2, 4 Sep.		A		A	
1970					C-28 May		A	
1971					A		A	
1972					A		C-8 May	
1973					A		A	
1974					A		A	
1975					A		A	
1976					A		A	
1977					A		D-28 Feb.	
1978					D-3 Mar., F-10 Jul.			
1979-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	53 M 1970 3	Number: Sex: Year of birth: Mother's Number:	670 F 1970 6	Number: Sex: Year of birth: Mother's Number:	55 M 1970 10	Number: Sex: Year of birth: Mother's Number:	58 M 1970 40
1967-69								
1970	B		B, C-23 Jul.		B		B	
1971	A		A		C-10 Aug., D-10 Aug., F-10 Aug.		C-31 Aug.	
1972	E to Pen 2, 12 Oct.		A				A	
1973			E to Pen 2, 30 Sep.				A	
1974							A	
1975							A	
1976							A	
1977							A	
1978							A	
1979							A	
1980							A	
1981							A	
1982							A	
1983							D-31 Mar., F-11 May	

## Appendix A. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: 41 Sex: F Year of birth: ? Mother's Number: ?	Number: 4170 Sex: M Year of birth: 1970 Mother's Number: 41	Number: 61 Sex: F Year of birth: 1962 Mother's Number: ?	Number: 371 Sex: F Year of birth: 1971 Mother's Number: 3
1970	IA from outside-13 Oct., C-14 Oct.	IA from outside-13 Oct.	IA from outside-14 Oct.	
1971	R. to outside-23 Feb.	C-23 Feb., R. to Pen 4, 23 Feb.	C-2 Sep.	B, C-31 Aug.
1972			E to Pen 2, 15 Sep.	D-1 Jan.
1973				F-17 May
1974-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 6	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 10	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 40	Number: UC Sex: ? Year of birth: 1971 Mother's Number: R70-8
1967-70				
1971	B	B	B	B
1972	D-1 Jan.	D-1 Jan.	D-1 Jan.	D-1 Jan.
1973-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 61	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 61	Number: 64 Sex: M Year of birth: 1969 Mother's Number: ?	Number: UC Sex: M Year of birth: 1970 Mother's Number: ?
1967-70				
1971	B	B	IA from outside-28 Oct.	IA from outside-28 Sep.
1972	D-1 Jan.	D-1 Jan.	C-2 Apr.	D-1 Mar.
1973			D-6 Jun., F-6 Jun.	
1974-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: M Year of birth: 1970 Mother's Number: ?	Number: UC Sex: ? Year of birth: 1972 Mother's Number: 10	Number: 76 Sex: F Year of birth: 1963 Mother's Number: ?	Number: UC Sex: ? Year of birth: 1972 Mother's Number: 76
1967-70				
1971	IA from outside-3 Nov.		IA from Pen 2, 12 Oct.	IA from Pen 2, 12 Oct.
1972	D-1 Mar.	B	D-25 May, F-18 Jun.	D-20 Feb.
1973		D-1 Jan.		
1974-83				

## Appendix A. Continued.

Status of Moose on Yearly basis <sup>b</sup>	Number: 93 Sex: M Year of birth: 1969 Mother's Number: ?	Number: 96 Sex: M Year of birth: 1972 Mother's Number: ?	Number: 1111e Sex: F Year of birth: 1972 Mother's Number: ?	Number: 65 Sex: M Year of birth: 1970 Mother's Number: 76
1967-1971 1972	IA from outside-11 Oct. C-14 Nov., D-14 Nov., F-14 Nov.	IP from outside-22 Dec. C-22 Dec.	IP from outside-19 Oct. D-1 Nov.	IP from Pen 2, 1 Dec.
1973 1974-83		D-19 Jan., F-23 Jan.		D-5 Feb., F-5 Feb.
Status of Moose on Yearly Basis <sup>b</sup>	Number: 99 Sex: M Year of birth: 1973 Mother's Number: R70-8	Number: 101 Sex: F Year of birth: 1973 Mother's Number: 40	Number: 107 Sex: M Year of birth: 1973 Mother's Number: 3	Number: 109 Sex: F Year of birth: 1973 Mother's Number: 10
1967-72 1973	B, C-7 Jun.	B, C-9 Jul., E into Pen 2-30 Sep.	B, C-5 Sep., E to Pen 2-30 Sep.	B, C-11 Sep.
1974 1975-83	D-15 Mar., F-19 Jun.			D-7 Aug., F-9 Aug.
Status of Moose on Yearly Basis <sup>b</sup>	Number: 116 Sex: M Year of birth: 1974 Mother's Number: 10	Number: 125 Sex: F Year of birth: 1966 Mother's Number: ?	Number: UC Sex: M Year of birth: 1975 Mother's Number: 69	Number: UC Sex: ? Year of birth: 1975 Mother's Number: R70-8
1967-73 1974 1975	B, C-5 Sep. D-15 Jan., F-10 Apr.	IA from outside-20 Feb., C-21 Feb.	B D-22 Sep., F-22 Sep.	B A D-31 Mar.
1976 1977 1978 1979 1980 1981 1982 1983		A A A A A A D-31 Jan., F-25 Jul.		
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: ? Year of birth: 1976 Mother's Number: R70-8	Number: UC Sex: M Year of birth: 1976 Mother's Number: 125	Number: UC Sex: F Year of birth: 1978 Mother's Number: R70-8	Number: 8 Sex: M Year of birth: 1978 Mother's Number: 125
1967-75 1976 1977 1978 1979 1980 1981 1982 1983	B, D-9 Jul.	B A A A D-31 Mar.	B A A D-28 Feb. F-25 May	B C-11 Jul. A A A

## Appendix A. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: 5 Sex: M Year of birth: ? Mother's Number: ?	Number: UC Sex: M Year of birth: ? Mother's Number: ?	Number: 37-83 Sex: F Year of birth: 1980 Mother's Number: R70-8	Number: 29-83 Sex: F Year of birth: ? Mother's Number: ?
1967-77				
1978	IA from outside-7 Oct.	IA from outside 7 Oct.		
1979	C-23 Oct., R. to Pen, 3-23 Oct.	D-28 Feb., F-22 Jun.		
1980			B	IA from outside-30 Apr.
1981			A	A
1982			A	A
1983			A	A
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: F Year of birth: 1980 Mother's Number: 29-83	Number: UC Sex: ? Year of birth: 1981 Mother's Number: R70-8	Number: UC Sex: F Year of birth: 1981 Mother's Number: 125	Number: UC Sex: F Year of birth: 1981 Mother's Number: 125
1967-79				
1980	B			
1981	A	B, D-22 Jun.	B	B
1982	A		A	A
1983	A		C-18 Mar.	A
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: F Year of birth: ? Mother's Number: ?	Number: UC Sex: ? Year of birth: 1981 Mother's Number: ?		
1967-80				
1981	IA from outside-31 Jul.	IA from outside-31 Jul.		
1982	E to outside-30 Sep.	D-31 Jan.		
1983	A			

<sup>a</sup> In some cases, a moose was assumed (but not known) to have a certain mother. This was based on the age of the moose and on sightings of the assumed mother with an UC calf. Also, ages of UC moose are not known after they are two years old and are sometimes assumed from sightings of calves and yearlings during previous years.

<sup>b</sup> Status Codes: A = Alive; B = Born in the pen; C = Collared and/or tagged for first time or retagged after losing all identification; D = Dead (actual or estimated death date given); E = Escaped from pen (actual or estimated date given); F = Found dead; IA = Introduced accidentally to pen by breaking in from outside or escaping from another pen (actual or estimated date given); IP = Purposely introduced to pen from outside or from another pen; P = Penned in when enclosures were completed; and R = Released or moved from pen to outside or into another pen.



Appendix B. Chronological histories of moose in Pen 2 at Kenai Moose Research Center (January 1967-June 1983).

Moose Identification <sup>a</sup>								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	7 (R70-7) F 1963 ?	Number: Sex: Year of birth: Mother's Number:	11 F ? ?	Number: Sex: Year of birth: Mother's Number:	12 F 1961 ?	Number: Sex: Year of birth: Mother's Number:	13 F ? ?
1967	P-Jan.		P-Jan.		P-Jan.		P-Jan.	
1968	C-24 Jan.		C-24 Jan.		C-24 Jan.		C-24 Jan., D-1 Jul.	
1969	A		A		D-5 Jul., F-7 Jul.			
1970	A		D-1 Jan.					
1971	A		F-3 Jun.					
1972	A							
1973	D-28 Apr., F-18 Jun.							
1974-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	14 F 1959/61 ?	Number: Sex: Year of birth: Mother's Number:	15 F 1965 ?	Number: Sex: Year of birth: Mother's Number:	16 F 1958 ?	Number: Sex: Year of birth: Mother's Number:	3995 F 1962 ?
1967	P-Jan.		P-Jan.		P-Jan.		P-Jan.	
1968	C-24 Jan.		C-25 Jan.		C-25 Jan.		C-25 Jan.	
1969	D-1 Aug., F-Aug.		D-1 Jan.		A		D-1 Jun., F-8 Jul.	
1970					D-15 Feb., F-Jul.			
1971-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	17 F 1967 ?	Number: Sex: Year of birth: Mother's Number:	36 M 1967 13	Number: Sex: Year of birth: Mother's Number:	R70-2 F 1967 14	Number: Sex: Year of birth: Mother's Number:	4250 M 1967 ?
1967	B		B		B		B	
1968	C-25 Jan., D-1 Mar., F-25 Apr.		A		A		C-25 Jan., D-15 Feb.	
1969			A		A			
1970			C-30 Jan.		C-22 May			
1971			A		D-15 Jul., F-15 Jul.			
1972			A					
1973			A					
1974			A					
1975			A					
1976			A					
1977			E to Pen 3, 2 Oct.					

## Appendix B. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: 45 Sex: M Year of birth: 1968 Mother's Number: 1	Number: 52 Sex: F Year of birth: 1968 Mother's Number: 2	Number: 1 Sex: F Year of birth: 1963/64 Mother's Number: ?	Number: 2 (R69-3) Sex: F Year of birth: 1963 Mother's Number: ?
1967				
1968	IA from Pen 1, 4 Sep.	IA from Pen 1, 4 Sep.	IA from Pen 1, 4 Sep.	IA from Pen 1, 4 Sep.
1969	C-21 Oct.	C-23 Jul.	A	A
1970	A	A	A	A
1971	A	A	A	A
1972	A	A	A	D-1 Apr.
1973	D-8 Feb., F-8 Feb.	D-26 Apr., F-10 May	A	
1974			A	
1975			A	
1976			A	
1977			D-31 Mar., F-3 Jul.	
1978-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 9 Sex: F Year of birth: 1962 Mother's Number: ?	Number: 62 Sex: F Year of birth: 1952 Mother's Number: ?	Number: 70 Sex: F Year of birth: 1967 Mother's Number: ?	Number: 77 Sex: F Year of birth: 1966 Mother's Number: ?
1967		P-Jan.	B	P-Jan.
1968	IA from Pen 1, 4 Sep.	A	A	A
1969	A	A	A	A
1970	A	A	A	A
1971	A	C-1 Dec.	A	A
1972	D-15 Apr.	D-28 Jan., F-28 Jan.	D-8 May, F-8 May	C-10 May
1973				D-26 Apr., F-26 Apr.
1974-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 79 Sex: F Year of birth: 1969 Mother's Number: 7 (R70-7)	Number: UC Sex: M Year of birth: 1969 Mother's Number: 9	Number: UC Sex: M Year of birth: 1969 Mother's Number: 9	Number: 78 Sex: M Year of birth: 1969 Mother's Number: ?
1969				
1968				B
1969	B	B, C-11 Jun., D-11 Jun.	B, C-11 Jun., D-15 Jun.	A
1970	A			A
1971	A			A
1972	C-10 Jul.			C-30 Jun., D-30 Jul., F-3 Aug.
1973	A			
1974	A			
1975	A			
1976	D-5 Mar., F-5 Mar.			
1977-83				

## Appendix B. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: 54 Sex: M Year of birth: 1970 Mother's Number: 52	Number: 65 Sex: M Year of birth: 1970 Mother's Number: R70-2	Number: 73 (140) Sex: M Year of birth: 1969 Mother's Number: ?	Number: Walter Sex: M Year of birth: 1969 Mother's Number: ?
1967-68				
1969			B	
1970	B	B	A	IP from calf pen - 30 Nov.
1971	C-27 Jul.	A	A	D-30 Jul., F-30 Jul.
1972	D-15 Mar., F-18 Apr.	C-2 Apr., R to outside- 1 Dec.	C-10 May	
1973			A	
1974			A	
1975			A	
1976			A	
1977			E to Pen 3 - 2 Oct.	
1978-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: Richard Sex: M Year of birth: 1969 Mother's Number: ?	Number: R70-4 Sex: F Year of birth: 1967 Mother's Number: ?	Number: Boltar Sex: M Year of birth: 1970 Mother's Number: R70-4	Number: R70-5 Sex: F Year of birth: 1961 Mother's Number: ?
1967-69				
1970	IP from calf pen-30 Nov.	IP from outside-23 May	IP from outside-23 May, taken for study-24 May	IP from outside-24 May, D-256 May, F-27 May
1971	D-10 Aug., F-10 Aug.	A		
1972		A		
1973		A		
1974		D-17 Jul., F-17 Jul.		
1975-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 1-71 Sex: F Year of birth: 1971 Mother's Number: 1	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 2	Number: UC Sex: ? Year of birth: 1971 Mother's Number: R70-7	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 9
1967-70				
1971	B, C-12 Aug.	B	B	B
1972	D-1 Jan.	D-1 Jan.	D-1 Jan.	D-1 Jan.
1973-83				

## Appendix B. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC ? 1971 9	Number: Sex: Year of birth: Mother's Number:	UC ? 1971 R70-4	Number: Sex: Year of birth: Mother's Number:	5271 M 1971 52	Number: Sex: Year of birth: Mother's Number:	40 F 1967 4
1967-70 1971 1972  1973 1974 1975 1976-83	B D-1 Jan.		B D-1 Jan.		B, C-27 Jul. D-1 Jan., F-20 Jun.		IA from Pen 1, 12 Oct., R into Pen 1, 1 Dec. IA from Pen 1, 30 Sep. A D-3 Mar., F-10 Mar.	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	43 M 1967 ?	Number: Sex: Year of birth: Mother's Number:	53 M 1970 3	Number: Sex: Year of birth: Mother's Number:	61 F 1962 ?	Number: Sex: Year of birth: Mother's Number:	63 F 1967 ?
1967-71 1972  1973 1974 1975-83	IA from Pen 1-15 Sep.		IA from Pen 1-12 Oct., R into Pen 4, 15 Nov.		IA from Pen 1-15 Sep.		IA from outside-14 Feb., C-22 Mar., D-1 Apr., F-8 May	
	R into Pen 1, 7 Feb.				A D-8 Aug., F-8 Aug.			
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	66 F 1962 ?	Number: Sex: Year of birth: Mother's Number:	68 F  	Number: Sex: Year of birth: Mother's Number:	76 F 1963 ?	Number: Sex: Year of birth: Mother's Number:	UC M ? ?
1967-71 1972  1973-83	IA from outside-21 Jan., C-2 Apr., D-2 Apr., F-2 Apr.		IA from outside-12 Feb., C-8 May, D-23 May, F-20 Jun.		IA from outside-12 Feb., C-10 May, E to Pen 1, 12 Oct.		IA from outside-18 Mar., D-10 Jul., F-10 Jul.	

## Appendix B. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	Raquel F 1969 ?	Number: Sex: Year of birth: Mother's Number:	82 F 1972 79	Number: Sex: Year of birth: Mother's Number:	83 M 1972 52	Number: Sex: Year of birth: Mother's Number:	UC ? 1972 76
1967-71								
1972	IP from calf pen-2 Oct.		B, C-10 Aug.		B, C-6 Sep.		B, E to Pen 1, 12 Oct.	
1973	R into calf pen-5 Apr., IP from calf pen-13 Jul., R into calf pen-24 Sep., IP from calf pen-8 Oct.		D-20 Feb., F-20 Feb.		D-15 Feb.			
1974	R into calf pen-12 Feb., IP from calf pen-13 Feb.							
1975	A							
1976	A							
1977	D-31 May							
1978-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC F 1972 R70-7	Number: Sex: Year of birth: Mother's Number:	3 F 1962 ?	Number: Sex: Year of birth: Mother's Number:	107 M 1973 3	Number: Sex: Year of birth: Mother's Number:	108 M 1973 79
1967-71								
1972	B							
1973	D-10 Mar.		IA from Pen 1, 30 Sep.		IA from Pen 1, 30 Sep.		B, C-6 Sep.	
1974			A		D-15 Mar.		D-15 Mar.	
1975			D-16 Mar.					
1976-82								
1983			F-26 Jul.					
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	97 M 1972 ?	Number: Sex: Year of birth: Mother's Number:	670 F 1970 6	Number: Sex: Year of birth: Mother's Number:	Wally, Jr. M 1971 Raquel	Number: Sex: Year of birth: Mother's Number:	Rastus M 1973 Raquel
1967-72								
1973	IP from outside-24 Jan., D-28 Jan., F-1 Feb.		IA from Pen 1, 30 Sep.		IP from calf pen-24 Jul., R into calf pen, 6 Sep., IP from calf pen-8 Oct.		IP from calf pen-13 Jul., R into calf pen, 24 Sep., IP from calf pen-8 Oct.	
1974			A		R into calf pen-12 Feb., IP from calf pen-13 Feb., R into calf pen-15 Aug., IP from calf pen-12 Sep.		R into calf pen-12 Feb., IP from calf pen-13 Feb.	
1975			A		D-17 Feb., F-6 Mar.		A	
1976			A				D-26 Feb., F-26 Feb.	
1977			A					
1978			A					
1979			D-31 Jan.					
1980-83								

## Appendix B. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	101 F 1973 40	Number: Sex: Year of birth: Mother's Number:	UC ? 1974 R70-4	Number: Sex: Year of birth: Mother's Number:	UC ? 1974 670	Number: Sex: Year of birth: Mother's Number:	117 F 1974 79
1967-72								
1973	IA from Pen 1-30 Sep.							
1974	D-15 Mar.			B	B		B, C-11 Sep.	
1975				D-26 Jan.	D-31 Jan.		D-31 Jan., F-2 Feb.	
1976-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	119 F 1974 40	Number: Sex: Year of birth: Mother's Number:	120 F 1971 ?	Number: Sex: Year of birth: Mother's Number:	122 M 1968 ?	Number: Sex: Year of birth: Mother's Number:	124 F 1969 ?
1967-73								
1974	B, C-17 Dec.							
1975	D-18 Jan., F-22 Jan.			IA from outside-2 Jan., C-14 Jan.	IA from outside-1 Jan., C-4 Feb., R into Pen 4, 4 Feb.		IA from outside-1 Jan., C-4 Feb., R into Pen 4, 4 Feb.	
1976				A				
1977				D-31 Jan				
1978-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	130 (Olive) F 1975 Raquel	Number: Sex: Year of birth: Mother's Number:	P. J. M 1975 Raquel	Number: Sex: Year of birth: Mother's Number:	UC F 1975 1	Number: Sex: Year of birth: Mother's Number:	UC F 1975 79
1967-74								
1975	B-20 May			B-20 May	B		B, D-15 Sep.	
1976	C-25 Feb.			C-28 Jan., D-29 Feb., F-15 Mar.	A			
1977	A				A			
1978	A				A			
1979	D-2 Aug., F-2 Aug.				A			
1980					A			
1981					A			
1982					A			
1983					A			

## Appendix B. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	141 (Mike) M 1976 Raquel	Number: Sex: Year of birth: Mother's Number:	142 (Ike) M 1976 Raquel	Number: Sex: Year of birth: Mother's Number:	129 F 1976 1	Number: Sex: Year of birth: Mother's Number:	UC ? 1976 670
1967-75								
1976	B, C-4 Nov.		B, C-9 Nov.		B		B, D-5 Jun.	
1977	A		R to outside-6 Oct.		C-30 Sep.			
1978	R to outside-2 Dec.				A			
1979					A			
1980					A			
1981					R to outside-5 Apr.			
1982-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	300 M 1976 120	Number: Sex: Year of birth: Mother's Number:	UC ? 1977 670	Number: Sex: Year of birth: Mother's Number:	67 M 1975 ?	Number: Sex: Year of birth: Mother's Number:	UC F ? ?
1967-75								
1976	B		B		IA from outside-16 Sep.,			
1977	C-5 Oct., R to outside-5 Oct.				C-6 Dec.			
1978			D-31 Mar., F-Jun.		E into Pen 3-6 Jan.		IA from Pen 3, 6 Jan.	
1979							A	
1980							R to outside-9 Aug.	
1981-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	59 M ? ?	Number: Sex: Year of birth: Mother's Number:	UC M 1976 ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1978 670	Number: Sex: Year of birth: Mother's Number:	UC M 1978 130 (Olive)
1967-76								
1977	IA from outside-22 Nov., C-6 Dec.							
1978	R to outside-8 Jun.		IA from outside-1 May, R to outside-5 Sep.		B, D-30 Jun.		B	
1979							D-15 Jan.	
1980-83								

Appendix B. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC F 1979 130 (Olive)	Number: Sex: Year of birth: Mother's Number:	UC M 1979 129	Number: Sex: Year of birth: Mother's Number:	UC M 1979 ?	Number: Sex: Year of birth: Mother's Number:	UC F ? ?
1967-78								
1979	B		B					
1980	A		A		IA from outside-8 Feb.		IA from outside-8 Feb.	
1981	A		R to outside-5 Apr.		A		A	
1982	A				A		A	
1983	A				A		A	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC F ? ?	Number: Sex: Year of birth: Mother's Number:	31 F ? ?	Number: Sex: Year of birth: Mother's Number:	UC M 1981 ?	Number: Sex: Year of birth: Mother's Number:	33-83 F ? ?
1967-79								
1980	IA from outside-24 Apr., R to outside-2 May		C-10 Jun., IP from Pen 4, 10 Jun. E to outside-31 Aug.					
1981					B		IA from outside-9 Oct.	
1982					R to outside- 9 Dec.		A	
1983							C-15 Mar.	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC M 1981 33-83	Number: Sex: Year of birth: Mother's Number:	UC ? 1982 ?	Number: Sex: Year of birth: Mother's Number:		Number: Sex: Year of birth: Mother's Number:	
1967-80								
1981	IA from outside-9 Oct.							
1982	A		B					
1983	A		D-15 Mar.					

<sup>a</sup> In some cases, a moose was assumed (but not known) to have a certain mother. This was based on the age of the moose and on sightings of the assumed mother with an UC calf. Also, ages of UC moose are not known after they are two years old and are sometimes assumed from sightings of calves and yearlings during previous years.

<sup>b</sup> Status Codes: A = Alive; B = Born in the pen; C = Collared and/or tagged for first time or retagged after losing all identification; D = Dead (actual or estimated death date given); E = Escaped from pen (actual or estimated date given); F = Found dead; IA = Introduced accidentally to pen by breaking in from outside or escaping from another pen (actual or estimated date given); IP = Purposely introduced to pen from outside or from another pen; P = Penned in when enclosures were completed; and R = Released or moved from pen to outside or into another pen.



Appendix C. Chronological histories of moose in Pen 3 at Kenai Moose Research Center (January 1967-June 1983).

Moose Identification<sup>a</sup>

Status of Moose on Yearly Basis <sup>b</sup>	Number: 26 Sex: F Year of birth: 1961 Mother's Number: ?	Number: UC Sex: ? Year of birth: 1969 Mother's Number: 26	Number: 27 Sex: F Year of birth: 1966 Mother's Number: ?	Number: 75 (LBRE) <sup>c</sup> Sex: F Year of birth: 1969 Mother's Number: 27
1969	P-Aug., C-23 Sep.	P-Aug., D-31 Dec.	P-Aug., C-26 Sep.	P-Aug.
1970	D-19 May, F-19 May		A	A
1971			A	A
1972			A	C-10 May
1973			A	A
1974			A	A
1975			A	A
1976			D-30 Apr.	A
1977				A
1978			F-28 Jun.	A
1979				A
1980				A
1981				A
1982				A
1983				D-31 Mar.

31

Status of Moose on Yearly Basis <sup>b</sup>	Number: 28 Sex: F Year of birth: 1962 Mother's Number: ?	Number: 32 Sex: F Year of birth: 1968 Mother's Number: ?	Number: 38 Sex: F Year of birth: 1954 Mother's Number: ?	Number: 39 Sex: F Year of birth: 1965 Mother's Number: ?
1969	P-Aug., C-6 Oct.	P-Aug., D-23 Oct., F-23 Oct.	P-Aug.	P-Aug.
1970	A		C-10 Jul.	C-28 Jul.
1971	D-12 Aug., F-12 Aug.		A	A
1972			A	A
1973			A	A
1974			D-15 Mar., F-18 Apr.	A
1975				A
1976				A
1977				A
1978				E to Pen 4, 30 Sep.
1979-83				

Status of Moose on Yearly Basis <sup>b</sup>	Number: 60 Sex: M Year of birth: 1967 Mother's Number: ?	Number: UC Sex: F Year of birth: ? Mother's Number: ?	Number: 20 Sex: F Year of birth: 1960 Mother's Number: ?	Number: 80 Sex: M Year of birth: 1969 Mother's Number: 20
1969	P-Aug.	P-Aug.	1A from Pen 4, 1 Sep.	1A from Pen 4, 1 Sep.
1970	C-15 May	A	A	A
1971	D-31 Aug., F-31 Aug.	A	A	A
1972		D-1 Jun.	D-15 Feb., F-20 Jun.	C-14 Jul.
1973				A
1974				A
1975				A

## Appendix C. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: 60 Sex: M Year of birth: 1967 Mother's Number: ?	Number: UC Sex: F Year of birth: ? Mother's Number: ?	Number: 20 Sex: F Year of birth: 1960 Mother's Number: ?	Number: 80 Sex: M Year of birth: 1969 Mother's Number: 20
1976				A
1977				A
1978				R into Pen 4, 19 Sep.
1979-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 2870 Sex: F Year of birth: 1970 Mother's Number: 28	Number: 72(13) <sup>d</sup> Sex: F Year of birth: 1970 Mother's Number: 39	Number: 2071 Sex: M Year of birth: 1971 Mother's Number: 20	Number: 2771 Sex: F Year of birth: 1971 Mother's Number: 27
1969				
1970	B, C-12 Aug.	B		
1971	A	A	B, C-10 Aug.	B, C-27 Jul.
1972	A	C-9 May	D-1 Jan.	D-16 Feb., F-16 Feb.
1973	A	A		
1974	A	A		
1975	A	A		
1976	A	A		
1977	A	A		
1978	A	C-18 Jul.		
1979	A	A		
1980	D-31 Mar.	A		
1981		A		
1982		A		
1983		D-15 Apr., F-20 Jul.		
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 39	Number: UC Sex: ? Year of birth: 1971 Mother's Number: ?	Number: 67 Sex: F Year of birth: 1970 Mother's Number: ?	Number: 98 Sex: M Year of birth: 1973 Mother's Number: 72(13)
1969-70				
1971	B	B	1A from outside-15 Oct.	
1972	D-1 Jan.	D-15 Feb.	C-8 Apr., D-15 Apr., F-9 May	
1973				B
1974				C-29 May, D-7 Aug.
1975-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 104 Sex: M Year of birth: 1973 Mother's Number: 39	Number: 114 Sex: F Year of birth: 1974 Mother's Number: 27	Number: UC Sex: ? Year of birth: 1974 Mother's Number: 72(13)	Number: UC Sex: F Year of birth: ? Mother's Number: ?
1969-72				
1973	B, C-7 Aug.			
1974	D-15 Mar.	B, C-7 Jun.	B	1A from outside-5 Feb.
1975		D-10 Feb.	D-18 Jan.	

## Appendix C. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	104 M 1973 39	Number: Sex: Year of birth: Mother's Number:	114 F 1974 27	Number: Sex: Year of birth: Mother's Number:	UC ? 1974 72(13)	Number: Sex: Year of birth: Mother's Number:	UC F ? ?
1976 1977 1978 1979-83							A A E into Pen 2, 6 Jan.	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC ? 1975 2870	Number: Sex: Year of birth: Mother's Number:	UC ? 1975 72(13)	Number: Sex: Year of birth: Mother's Number:	UC M 1975 ?	Number: Sex: Year of birth: Mother's Number:	17(UC) <sup>e</sup> F 1976 ?
1969-74 1975 1976 1977 1978 1979 1980 1981 1982 1983	B, D-30 Sep.		B, D-30 Sep.		B A A R to outside-15 Jun.		B A A A C-17 Jul. A A A A	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC ? 1976 72(13)	Number: Sex: Year of birth: Mother's Number:	UC ? 1976 75(LBRE)	Number: Sex: Year of birth: Mother's Number:	UC ? 1977 ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1977 ?
1969-75 1976 1877 1978 1979-83	B A R to outside-14 Jun.		B A R to outside-14 Jun.		B D-31 Mar.		B D-31 Mar.	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	36 M 1967 13	Number: Sex: Year of birth: Mother's Number:	73(140) M 1969 ?	Number: Sex: Year of birth: Mother's Number:	67 M 1975 ?	Number: Sex: Year of birth: Mother's Number:	133 F 1968 ?
1969-76 1977 1978 1979-83	IA from Pen 2, 2 Oct. D-31 Jan., F-13 Jul.		IA from Pen 2, 2 Oct. R into Pen 4, 20 Sep.		IA from Pen 2, 6 Jan., R to outside-8 Jun.		IP from Pen 4, 28 Jun., D-31 Aug., F-12 Sep.	

## Appendix C. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	5090 F 1978 133	Number: Sex: Year of birth: Mother's Number:	UC F 1978 75(LBRE)	Number: Sex: Year of birth: Mother's Number:	UC ? 1978 75(LBRE)	Number: Sex: Year of birth: Mother's Number:	UC ? 1978 2870
1969-77								
1978	IP from Pen 4, 28 Jun., D-28 Jun., F-28 Jun.		B		B		B	
1979			A		A		D-28 Feb.	
1980			A		D-31 Mar.			
1981			A					
1982			A					
1983			A					
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC ? 1978 ?	Number: Sex: Year of birth: Mother's Number:	5 M 1974 ?	Number: Sex: Year of birth: Mother's Number:	20 F ? ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1980 20
1969-77								
1978	B, D-16 Jul.							
1979			IP from Pen 1, 23 Oct.					
1980			A		C-8 Jun., IP from Pen 4, 8 Jun.		IP from Pen 4, 8 Jun., D-30 Jun	
1981			R into Pen 4, 15 Jun., IA from Pen 4, 1 Oct.		A			
1982			A		A			
1983			A		A			
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC F 1980 13	Number: Sex: Year of birth: Mother's Number:	18 F ? ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1981 18	Number: Sex: Year of birth: Mother's Number:	UC ? 1981 13
1969-79								
1980	B							
1981	A		IA from Pen 4, 10 Jun., C-24 Jun.		IA from Pen 4, 10 Jun., D-30 Jun.		B, D-30 Jun.	
1982	A		A					
1983	A		A					
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC M 1981 76(LBRE)	Number: Sex: Year of birth: Mother's Number:	UC M 1981 75(LBRE)				
1969-80								
1981	B		B					
1982	A		A					
1983	A		A					

- a In some cases, a moose was assumed (but not known) to have a certain mother. This was based on the age of the moose and on sightings of the assumed mother with an UC calf. Also, ages of UC moose are not known after they are two years old and are sometimes assumed from sightings of calves and yearlings during previous years.
- b Status Codes: A = Alive; B = Born in the pen; C = Collared and/or tagged for first time or retagged after losing all identification; D = Dead (actual or estimated death date given); E = Escaped from pen (actual or estimated date given); F = Found dead; IA = Introduced accidentally to pen by breaking in from outside or escaping from another pen (actual or estimated date given); IP = Purposely introduced to pen from outside or from another pen; P = Penned in when enclosures were completed; and R = Released or moved from pen to outside or into another pen.
- c No. 75. Female was assumed to be the same moose that was later referred to as LBRE because she had a light blue ear flag.
- d No. 13. Female was assumed to be the moose that had previously been No. 72. Female No. 13 had definitely been tagged but had lost all identification.
- e No. 17. Female was assumed to be the 1976 calf of an UC cow in Pen 3. Since No. 17 was not collared until 1979, her actual origin is not known.

Appendix D. Chronological histories of moose in Pen 4 at Kenai Moose Research Center (January 1967-June 1983).

Moose Identification<sup>a</sup>

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	20 F 1960 ?	Number: Sex: Year of birth: Mother's Number:	80 M 1969 20	Number: Sex: Year of birth: Mother's Number:	21 M 1968 ?	Number: Sex: Year of birth: Mother's Number:	22 F 1965 ?
1969	P-Aug., C-6 Aug., E into Pen 3, 1 Sep.		P-Aug., E into Pen 3, 1 Sep.		P-Aug., C-Fall		P-Aug., C-Fall	
1970					A		A	
1971					A		A	
1972					D-15 Feb., F-26 Feb.		A	
1973							A	
1974							A	
1975							D-21 Feb., F-25 Feb.	
1976-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	37 F 1969 22	Number: Sex: Year of birth: Mother's Number:	23 F 1958 ?	Number: Sex: Year of birth: Mother's Number:	7 M 1969 23	Number: Sex: Year of birth: Mother's Number:	UC ? 1969 23
1969	P-Aug.		P-Aug., C-4 Sep.		P-Aug.		P-Aug.	
1970	C-1 Oct.		D-1 Apr., F-13 Apr.		C-4 Jun.		D-15 Jan.	
1971	A				A			
1972	A				A			
1973	A				A			
1974	A				A			
1975	A				A			
1976	A				A			
1977	A				A			
1978	A				A			
1979	D-30 Apr.				D-31 Mar.			
1980-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	24 F 1962 ?	Number: Sex: Year of birth: Mother's Number:	71 F 1969 24	Number: Sex: Year of birth: Mother's Number:	25 F 1959 ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1969 25
1969	P-Aug., C-Fall		P-Aug.		P-Aug., C-5 Sep.		P-Aug.	
1970	A		A		D-15 Apr., F-31 Jul.		D-15 Feb.	
1971	A		A					
1972	D-15 Mar., F-10 May		C-9 May					
1973			A					
1974			A					
1975			A					
1976			A					
1977			A					
1978			A					

## Appendix D. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	24 F 1962 ?	Number: Sex: Year of birth: Mother's Number:	71 F 1969 24	Number: Sex: Year of birth: Mother's Number:	25 F 1959 ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1969 25
1979			A					
1980			A					
1981			A					
1982			D-26 Jan., F-26 Jan.					
1983								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	29 F 1964 ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1969 29	Number: Sex: Year of birth: Mother's Number:	31(R70-1) F 1963 ?	Number: Sex: Year of birth: Mother's Number:	59 M 1969 31(R70-1)
1969	P-Aug., C-14 Oct.		P-Aug.		P-Aug., C-12 Aug.		P-Aug.	
1970	D-1 Mar., F-23 Apr.		D-1 Feb.		A		A	
1971					D-25 Aug., F-25 Aug.		C-1 Sep.	
1972							A	
1973							A	
1974							A	
1975							A	
1976							D-31 Jan.	
1977-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	34 F 1956 ?	Number: Sex: Year of birth: Mother's Number:	36 F 1963 ?	Number: Sex: Year of birth: Mother's Number:	44 M 1968 ?	Number: Sex: Year of birth: Mother's Number:	A60 F 1957 ?
1969	P-Aug., C-11 Dec.		P-Aug.		P-Aug., C-9 Oct., D-1 Dec.		P-Aug.	
1970	A		C-23 Jul.				C-17 Jul.	
1971	A		A				A	
1972	D-1 Mar., F-23 Mar.		A		F-9 May		D-1 Apr., F-9 May	
1973			A					
1974			A					
1975			D-15 May, F-19 Jun.					
1976-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	R70-3 F 1967 ?	Number: Sex: Year of birth: Mother's Number:	56 M 1970 24	Number: Sex: Year of birth: Mother's Number:	57 F 1970 31(R70-1)	Number: Sex: Year of birth: Mother's Number:	74 F 1970 36
1969	P-Aug.							
1970	C-20 May		B		B		B	
1971	A		C-11 Aug.		C-25 Aug.		A	
1972	A		D-1 Apr., F-25 May		A		C-10 May, D-15 May, F-3 Jun.	
1973	D-26 Apr., F-26 Apr.				A			
1974					A			
1975					A			

## Appendix D. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: R70-3 Sex: F Year of birth: 1967 Mother's Number: ?	Number: 56 Sex: M Year of birth: 1970 Mother's Number: 24	Number: 57 Sex: F Year of birth: 1970 Mother's Number: 31(R70-1)	Number: 74 Sex: F Year of birth: 1970 Mother's Number: 36
1976 1977 1978-83			A D-28 Feb.	
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: ? Year of birth: 1970 Mother's Number: A60	Number: UC Sex: ? Year of birth: 1970 Mother's Number: R70-3	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 22	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 24
1969 1970 1971 1972 1973-83	B A D-1 Mar.	B A D-1 Mar.	B D-1 Jan.	B D-1 Jan.
Status of Moose on Yearly Basis <sup>b</sup>	Number: R70171 Sex: M Year of birth: 1971 Mother's Number: 31(R70-1)	Number: UC Sex: ? Year of birth: 1971 Mother's Number: 34	Number: A6071 Sex: M Year of birth: 1971 Mother's Number: A60	Number: R70371 Sex: F Year of birth: 1971 Mother's Number: R70-3
1969-70 1971 1972 1973-83	B, C-25 Aug., D-29 Dec., F-29 Dec.	B D-1 Jan.	B, C-10 Aug. D-1 Jan., F-16 Jun.	B, C-11 Aug., D-15 Dec. F-10 May
Status of Moose on Yearly Basis <sup>b</sup>	Number: 4170 Sex: M Year of birth: 1970 Mother's Number: 41	Number: 81 Sex: F Year of birth: 1969 Mother's Number: ?	Number: 84 Sex: F Year of birth: 1967 Mother's Number: ?	Number: UC(DA-2) Sex: F Year of birth: 1963 Mother's Number: ?
1969-70 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980-83	C-23 Feb., IP from Pen 1, D-1 Apr.	IA from outside-27 Oct. C-19 Jul. A A A A A A R to outside-17 Jul.	IP from outside-4 Nov. C-8 Sep. A A D-15 Mar., F-3 Jun.	IA from outside-9 Nov. D-1 Apr., F-10 May



## Appendix D. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: UC(DA-1) Sex: F Year of birth: 1968/69 Mother's Number: ?	Number: 128 Sex: F Year of birth: ? Mother's Number: ?	Number: 118 Sex: F Year of birth: 1970 Mother's Number: ?	Number: 121 Sex: M Year of birth: 1970 Mother's Number: ?
1969-70 1971	IP from outside-23 Nov.	1A from outside-2 Dec.	IP from outside-16 Nov., C-16 Nov.	IP from outside-23 Nov., C-23 Nov.
1972	D-1 Apr., F-27 Apr.	C-26 Jan.	A	D-1 Mar., F-23 Mar.
1973		D-1 May	D-13 Apr., F-13 Apr.	
1974				
1975				
1976		F-21 Jun.		
1977-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 123 Sex: F Year of birth: 1968 Mother's Number: ?	Number: 126 Sex: F Year of birth: 1954 Mother's Number: ?	Number: 9671 Sex: F Year of birth: 1971 Mother's Number: ?	Number: 9771 Sex: F Year of birth: 1971 Mother's Number: ?
1969-70 1971	IP from outside-1 Dec., C-1 Dec.	IP from outside-15 Dec., C-15 Dec.	IP from outside-21 Sep., C-21 Sep.	IP from outside-22 Sep., C-22 Sep.
1972	A	D-1 Mar., F-8 Mar.	D-1 Jan., F-10 May	D-1 Jan., F-14 Jan.
1973-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 9871 Sex: F Year of birth: 1971 Mother's Number: ?	Number: 10671 Sex: M Year of birth: 1971 Mother's Number: ?	Number: 10771 Sex: F Year of birth: 1971 Mother's Number: ?	Number: 10871 Sex: F Year of birth: 1971 Mother's Number: ?
1969-70 1971	IP from outside-29 Sep., C-29 Sep.	IP from outside-12 Oct., C-12 Oct., D-22 Dec., F-27 Dec.	IP from outside-12 Oct., C-12 Oct.	IP from outside-13 Oct., C-13 Oct., D-10 Dec., F-10 Dec.
1972	D-23 Jan., F-15 Jan.		D-1 Jan., F-14 Jan.	
1973-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 10971 Sex: F Year of birth: 1971 Mother's Number: ?	Number: 11071 Sex: M Year of birth: 1971 Mother's Number: ?	Number: 11471 Sex: M Year of birth: 1971 Mother's Number: ?	Number: 11571 Sex: F Year of birth: 1971 Mother's Number: ?
1969-70 1971	IP from outside-20 Oct., C-20 Oct.	IP from outside-21 Oct., C-21 Oct.	IP from outside-2 Nov., C-2 Nov.	IP from outside-3 Nov., C-3 Nov.
1972	D-1 Jan., F-15 Jan.	D-13 Jan., F-13 Jan.	D-1 Jan., F-6 Jun.	D-1 Jan., F-9 May
1973-83				

## Appendix D. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: 12071 Sex: M Year of birth: 1971 Mother's Number: ?	Number: 13471 Sex: M Year of birth: 1971 Mother's Number: ?	Number: R72-1 Sex: F Year of birth: 1962 Mother's Number: ?	Number: UC Sex: ? Year of birth: 1972 Mother's Number: 123
1969-70 1971	IP from outside-23 Nov., C-23 Nov., D-15 Dec., F-23 Dec.			
1972	IP from outside-22 Mar., C-22 Mar., D-23 Mar., F-23 Mar.		IP from outside-20 Apr., C-20 Apr., D-24 May, F-24 May	B, D-15 Nov.
1973-83				
Status of Moose on Yearly Basis <sup>b</sup>	Number: 53 Sex: M Year of birth: 1970 Mother's Number: 3	Number: 85 Sex: F Year of birth: 1961 Mother's Number: ?	Number: 86 Sex: M Year of birth: 1972 Mother's Number: 85	Number: 87 Sex: F Year of birth: 1961 Mother's Number: ?
1969-71 1972	IP from Pen 2, 15 Nov.	IP from outside-18 Sep., C-18 Sep.	IP from outside-18 Sep., C-18 Sep.	IP from outside-26 Oct., C-26 Oct.
1973 1974-83	D-1 Apr., F-10 May	D-15 May, F-19 Jun.	D-1 Feb., F-4 Mar.	D-1 Mar., F-19 Mar.
Status of Moose on Yearly Basis <sup>b</sup>	Number: 88 Sex: M Year of birth: 1972 Mother's Number: 87	Number: 89 Sex: F Year of birth: 1959 Mother's Number: ?	Number: 90 Sex: F Year of birth: 1972 Mother's Number: 89	Number: 91 Sex: F Year of birth: 1962 Mother's Number: ?
1969-71 1972	IP from outside-26 Oct., C-26 Oct.	IP from outside- 2 Nov., C-2 Nov.	IP from outside-2 Nov., C-2 Nov.	IP from outside-11 Nov., C-11 Nov.
1973 1974-83	D-7 Feb., F-13 Feb.	D-15 May, F-18 Jun.	D-25 Jan., F-26 Jan.	D-1 May, F-18 Jun.
Status of Moose on Yearly Basis <sup>b</sup>	Number: 92 Sex: F Year of birth: 1972 Mother's Number: 91	Number: 94 Sex: F Year of birth: 1972 Mother's Number: 149(outside)	Number: 95 Sex: F Year of birth: 1972 Mother's Number: 150(outside)	Number: UC Sex: ? Year of birth: 1973 Mother's Number: 22
1969-71 1972	IP from outside-11 Nov., C-11 Nov.	IP from outside-6 Dec., C-6 Dec.	IP from outside-6 Dec., C-6 Dec.	
1973 1974 1975-83	D-25 Jan., F-31 Jan.	D-1 Feb., F-9 May	D-30 Jan., F-31 Jan.	B D-15 Mar.

## Appendix D. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC ? 1973 71	Number: Sex: Year of birth: Mother's Number:	100 M 1969 ?	Number: Sex: Year of birth: Mother's Number:	102 F 1970 ?	Number: Sex: Year of birth: Mother's Number:	103 F 1970 ?
1969-72								
1973	B-18 Jun.		IP from outside-20 Jun., C-20 Jun.		IP from outside-10 Jul., C-10 Jul.		IP from outside-13 Jul., C-13 Jul.	
1974	D-15 Mar.		A		A		A	
1975			A		D-15 Mar., F-24 Jun.		A	
1976			A				A	
1977			A				D-31 Mar.	
1978			R to outside-7 Jul					
1979-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	105 F 1966 ?	Number: Sex: Year of birth: Mother's Number:	106 F 1964 ?	Number: Sex: Year of birth: Mother's Number:	110(UC) F ? ?	Number: Sex: Year of birth: Mother's Number:	111(197) F 1970 ?
1969-72								
1973	IP from outside-9 Aug.		1A from outside-15 Aug., C-15 Nov.		1A from outside-5 Oct., D-10 Oct.		IP from outside-9 Oct., C-9 Oct.	
1974	C-21 Feb.		D-1 Mar., F-18 Apr.				A	
1975	A						D-15 May	
1976	A							
1977	D-28 Feb.							
1978-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	112 F 1964 ?	Number: Sex: Year of birth: Mother's Number:	115 F 1963 ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1974 36	Number: Sex: Year of birth: Mother's Number:	UC ? 1974 84
1969-72								
1973	IP from outside-29 Nov., C-29 Nov.		IP from outside 8 Oct.,					
1974	D-15 Mar., F-17 Apr.		A		B, D-1 Sep.		B	
1975			D-15 Mar., F-23 Jun.				D-15 Jan.	
1976-83								
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC ? 1974 102	Number: Sex: Year of birth: Mother's Number:	UC ? 1974 111	Number: Sex: Year of birth: Mother's Number:	122 M 1968 ?	Number: Sex: Year of birth: Mother's Number:	124 F 1969 ?
1969-73								
1974	B		B-17 Jun., D-1 Sep.		IP from Pen 2, 4 Feb., C-4 Feb., D-5 Feb., F-2 May		IP from Pen 2, 4 Feb., C-4 Feb.	
1975	D-15 Jan.							
1976							A	
1977							D-30 Apr.	
1978-83								

## Appendix D. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC ? 1975 71	Number: Sex: Year of birth: Mother's Number:	UC M 1975 81	Number: Sex: Year of birth: Mother's Number:	UC ? 1975 105	Number: Sex: Year of birth: Mother's Number:	UC ? 1976 57
1969-74 1975 1976 1977 1978 1979-83	B, D-10 Jun.		B A A R to outside-16 Jun.		B, D-30 Jun.		B D-28 Feb.	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	UC M 1976 37	Number: Sex: Year of birth: Mother's Number:	UC ? 1977 71	Number: Sex: Year of birth: Mother's Number:	UC M 1977 81	Number: Sex: Year of birth: Mother's Number:	131 M 1977 ?
1969-75 1976 1977 1978 1979-83	B A D-7 Jun, F-7 Jun.		B F-28 Feb.		B R to outside-6 Jul.		IA from outside-30 Sep., C-4 Nov. D-31 Mar.	
42 Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	132 F 1970 ?	Number: Sex: Year of birth: Mother's Number:	133 F 1968 ?	Number: Sex: Year of birth: Mother's Number:	UC F ? ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1978 37
1969-76 1977 1978 1979 1980 1981 1982 1983	IA from outside-30 Sep., C-22 Nov. A D-31 Mar., F-4 May		IA from outside-15 Sep., C-6 Dec. R into Pen 3, 28 Jun.		IA from outside-30 Sep. A A A A A		B, D-29 May	
Status of Moose on Yearly Basis <sup>b</sup>	Number: Sex: Year of birth: Mother's Number:	Chester M 1978 ?	Number: Sex: Year of birth: Mother's Number:	UC ? 1978 71	Number: Sex: Year of birth: Mother's Number:	UC ? 1978 132	Number: Sex: Year of birth: Mother's Number:	5090 ? 1978 133
1969-77 1978 1979 1980-83	B, R into tame moose pen, 29 May		B D-31 Mar.		B D-28 Feb.		B, R into Pen 3, 28 Jun.	

## Appendix D. Continued.

Status of Moose on Yearly Basis <sup>b</sup>	Number: 80 Sex: M Year of birth: 1969 Mother's Number: 20	Number: 73(140) Sex: M Year of birth: 1969 Mother's Number: ?	Number: 39 Sex: F Year of birth: 1965 Mother's Number: ?	Number: UC Sex: M Year of birth: 1979 Mother's Number: ?
1969-77				
1978	IP from Pen 3, 19 Sep.	IP from Pen 3, 20 Sep.	IA from Pen 3, 30 Sep.	
1979	D-28 Feb.	D-31 Jan., F-26 Sep.	D-28 Feb., F-31 Mar.	B
1980				A
1981				A
1982				E to outside-31 Dec.
1983				
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: F Year of birth: ? Mother's Number: ?	Number: 20 Sex: F Year of birth: ? Mother's Number: ?	Number: UC Sex: ? Year of birth: 1980 Mother's Number: 20	Number: 31 Sex: F Year of birth: ? Mother's Number: ?
1969-78				
1979	IA from outside-30 Jun.			
1980	A	IA from outside-1 May, C-8 Jun., R into Pen 3, 8 Jun.	B, R into Pen 3, 8 Jun.	IA from outside-1 May, C-10 Jun., R into Pen 2, 10 Jun.
1981	A			
1982	E to outside-30 Jun.			
1983				
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: M Year of birth: ? Mother's Number: ?	Number: UC Sex: F Year of birth: ? Mother's Number: ?	Number: UC Sex: ? Year of birth: 1981 Mother's Number: ?	Number: UC Sex: F Year of birth: ? Mother's Number: ?
1969-79				
1980	IA from outside-16 Sep.			
1981	A	IA from outside-1 Feb., E to Pen 3, 10 Jun.	B, E to Pen 3, 10 Jun.	IA from outside-1 Feb.
1982	E to outside-15 Jul.			E to outside-31 Jan.
1983				
Status of Moose on Yearly Basis <sup>b</sup>	Number: UC Sex: F Year of birth: ? Mother's Number: ?	Number: 5 Sex: M Year of birth: 1974 Mother's Number: ?	Number: UC Sex: ? Year of birth: 1981 Mother's Number: ?	Number: UC Sex: ? Year of birth: 1981 Mother's Number: ?
1969-80				
1981	IA from outside-1 Feb.	IP from Pen 3, 15 Jun., E to Pen 3, 30 Sep.	B	B
1982	A		E to outside-31 Jan.	D-31 Mar.
1983	A			

Appendix D. Continued.

Status of	Number:	UC
Moose on	Sex:	?
Yearly basis <sup>b</sup>	Year of birth:	1981
	Mother's Number:	?
<hr/>		
1969-80		
1981	B	
1982	A	
1983	A	

- <sup>a</sup> In some cases, a moose was assumed (but not known) to have a certain mother. This was based on the age of the moose and on sightings of the assumed mother with an UC calf. Also, ages of UC moose are not known after they are two years old and are sometimes assumed from sightings of calves and yearlings during previous years.
- <sup>b</sup> Status Codes: A = Alive; B = Born in the pen; C = Collared and/or tagged for first time or retagged after losing all identification; D = Dead (actual or estimated death date given); E = Escaped from pen (actual or estimated date given); F = Found dead; IA = Introduced accidentally to pen by breaking in from outside or escaping from another pen (actual or estimated date given); IP = Purposely introduced to pen from outside or from another pen; P = Penned in when enclosures were completed; and R = Released or moved from pen to outside or into another pen.

## PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: None

Project No.: W-22-2      Project Title: Big Game Investigations

Job No.: 1.31R      Job Title: Evaluating and Testing  
of Techniques for Moose  
Management

Period Covered: 1 July 1982 through 30 June 1983

### SUMMARY

The experimental drug Carfentanil was used to immobilize 32 adult moose (Alces alces) in spring 1983. The drug proved very effective in these trials and had the advantage of being highly concentrated, allowing smaller quantities of the drug to be used for immobilization. The disadvantages are that it is not yet commercially available and it is a narcotic drug. Nevertheless, for moose it appears at this time to be drug of choice.

Expandable radio collars made from Ace bandage material were placed on moose calves during the calving season in May, and these collars were functional through June. Life and expandability of this system will be tested through the fall.

Late breeding experiments were conducted with tame moose at the Moose Research Center (MRC). Males and females were separated through early rut in fall 1982, then put together 15 October 1982. All females conceived, and births occurred on 28 May (premature twins); 7 June (twins; 1 normal, 1 mummified); 15 June (normal single); 17 June (normal single) and 17 June (normal single). Most females were bred soon after placing the moose together based upon calculated gestation periods. A trial withholding breeding till late October or early November would be useful to help refine the time late breeding may occur.

Snow depth data by habitat types from winters 1970-71 through 1982-83 were summarized and tabulated for use in designing browse utilization studies associated with testing the carrying capacity model being developed at the MRC.

Key words: Alces alces, evaluation, management, moose, Moose Research Center, testing, techniques.

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## BACKGROUND

The Moose Research Center (MRC) (Fig. 1), with known numbers of confined moose (Alces alces), provides unique conditions for developing and testing techniques applicable to moose management. Initiation and completion of studies under this job were predicated upon developments in related fields which provided drugs, equipment, and procedures potentially applicable to moose management. A final report covering activities under this project from July 1974 through June 1981 was completed (Franzmann and Schwartz 1982). A progress report on the renewal of this job and covering the period from 1 July 1981 through 30 June 1982 was submitted and published (Schwartz et al. 1983).

Franzmann and Schwartz (1982) recommended efforts continue in testing and evaluating new immobilizing drugs for moose based upon their conclusion that an ideal immobilizing drug for moose was not presently available. The drug Carfentanil (Janssen Pharmaceutica, Beerse, Belgium) was obtained, and permission to test the experimental drug was given by the Food and Drug Administration under Investigational New Animal Drug (INAD) permit #2685. Carfentanil use was reported for 20 species in South Africa (DeVos 1978) and for polar bears (Ursus maritimus) in the Canadian Arctic (Haigh et al. 1983). Researchers in Utah had also used the drug for elk (Cervus elaphus) and moose (J. Kimball, pers. commun.).



Moose calf mortality studies have been conducted on the Kenai Peninsula during summers of 1977 and 1978 in the 1947 Kenai Peninsula burn (Franzmann and Schwartz 1979). These studies were also done during summer 1982; in summer 1983, they were expanded to the 1969 Kenai Peninsula burn. Radio transmitters fitted with mortality sensors were applied to calves using expandable collars (Franzmann and Schwartz 1979). Ear tag transmitters were tried in 1982 and rejected (Schwartz et al. 1983). An expandable collar using Ace bandage material was developed, and it appeared to be the most satisfactory type collar for moose calves (Schwartz et al. 1983).

Late breeding experiments were conducted at the MRC using Pen 3, where all bulls were removed and a late introduction (23 Oct) of a mature bull was accomplished (Schwartz and Franzmann 1981). A calf was produced in early July, which indicated late breeding and conception occurred. However, we also determined that ordinary Super Cub overflights of the pen were not adequate for detecting all calving events in Pen 3. Vegetative overstory was too dense to adequately monitor the cows and calves. We had another option that was to utilize the hand-raised moose when they became sexually mature. These moose could be easily monitored. In fall 1982, we separated the tame male and female moose until 15 October.

Snow monitoring has been a continuing function at the MRC since snow plots were established in 1970 (LeResche and Davis 1971). Findings were utilized to reflect winter severity (LeResche et al. 1973; Franzmann and Arneson 1973, 1974, 1975; Franzmann and Schwartz 1983), food availability (LeResche et al. 1973, LeResche and Davis 1973), activity and behavior (Franzmann and Arneson 1973, LeResche et al. 1974, Sigman and Franzmann 1977), and movement and migrations (Bailey et al. 1978). A summary of snow depth data at the MRC was needed to supplement studies at the MRC for field validation of a moose carrying capacity model (Appendix A).

## OBJECTIVE

To test and evaluate techniques that are potentially useful for determining factors necessary for management of moose.

## PROCEDURES

### Immobilizing, Reversing, and Adjunct Drugs

Carfentanil was obtained and tested on adult moose in spring 1983. Animals at the MRC were trapped (LeResche and Lynch 1973) and immobilized using Cap-Chur equipment (Palmer Chemicals Co., Douglasville, Ga.). Projectile darts of 2 and 3 ml volume were

used. The drug was supplied in 1 ml ampules in a concentration of 10 mg Carfentanil/1 ml. The drug concentration was too great for ease in handling, and the product was diluted to 2 mg/1 ml. Free-ranging moose were immobilized using a Bell Jet Ranger helicopter from which the dart was fired.

Carfentanil, a morphine derivative, can be antagonized using diprenorphine hydrochloride (M50-50, Lemmon Co., Sellersville, Pa.) or naloxone hydrochloride (Narcan, Endo Pharmaceuticals, Inc., Manati, Puerto Rico). We used M50-50 because its concentration is more suitable to a large ungulate (2 mg/ml). Narcan is presently supplied in a concentration of 0.4 mg/ml. Narcan was available at all times on our project as the human antidote in event of accidental injection (Parker and Haigh 1982).

#### Radio Telemetry

Ace bandage expandable neck collars with radio transmitters sewn in (Schwartz et al. 1983) were placed on moose calves again during May 1983. Schwartz et al. (1983) indicated there were 2 unknowns regarding the Ace bandage collars: how long would they remain intact, and would moisture absorbed by the material be a problem.

#### Late Breeding

In early September 1982, female tame moose were separated from male moose and placed in holding pens; male moose were retained in the 4 ha pen adjacent to the experimental area (Fig. 1). The males were Chester and Chief, each 4½ years of age, and the females were Angel, Lucy, Jezebel, Trixie, and Oly. On 15 October, the females were turned into the 4-ha pen with the bulls.

#### Snow Plots

Snow plots established in 1970 (LeResche and Davis 1971), one each in the following habitat types: dense hardwoods, thin hardwoods, sedge meadow, spruce regrowth, birch-spruce regrowth (thin), birch-spruce regrowth (dense), and spruce-ledum. In November 1976, a plot was added to the mechanically rehabilitated area in the south end of Pen 1. A snow pillow was installed in Pen 1 during summer 1981 in conjunction and in cooperation with the U.S. Department of Agriculture, Soil Conservation Service.

### FINDINGS

#### Immobilizing, Reversing, and Adjunct Drugs

During spring 1983, 32 adult moose were immobilized using Carfentanil (Table 1). Eight moose were given 2.5 mg, 9 were given 3 mg, and 15 were given 4 mg. Corresponding mean immobilization

times were 7 min. 46 sec., 5 min. 15 sec., and 4 min. 44 sec., respectively. The 3 and 4 mg doses were satisfactory, while the 2.5 mg dose was adequate for some moose, but not generally. Dosages of 0.008 to 0.0011 mg/kg were considered the ideal dosage rate range.

The relatively fast immobilization times (4-5) significantly increased helicopter darting efficiency. Animals immobilized in this short time were all in dorsal recumbency and were considered "ideal" for processing (radio collaring, ear tagging, bleeding, collecting hair and tooth, measuring). The concentrated nature of the drug allowed use of smaller (2-3 ml) darts, which minimized damage at injection site; with the smaller volume of drug injected, absorption was more effective.

The dosage of antagonist M50-50 was 20 mg/moose (10 ml), 7 ml given intravenously and 3 ml intramuscularly. Response time varied considerably because no attempt was made to arouse the moose. We preferred to let the animal lie until it wanted to get up on its own. Mean up-time for moose given 4 mg Carfentanil was 4 min. 52 sec., 5 min. 18 sec. for moose given 3 mg, and 6 min. 17 sec. for moose given 2.5 mg.

Ten criteria were outlined that compromise an ideal immobilizing agent (Franzmann 1982): rapid absorption and action, concentrated form, wide range of tolerance for animal, safe for handler, reversibility, no side effects, effective anesthesia level, not subject to dangerous drug licensing, cleared for use on animal for food, and low cost.

Carfentanil ranks excellent for all criteria except 3 (safe for handler, not subject to dangerous drug licensing, and cleared for use on animal for food). Carfentanil is extremely dangerous to humans if accidentally injected (Parker and Haigh 1982), and it is subject to dangerous drug licensing. Carfentanil is not cleared for animals used for food, but guidelines are being developed that are similar to etorphine (M99, Lemmon Co., Sellersville, Pa.). These guidelines will provide a time frame for time of consumption following injection (B. Lance, pers. commun.) Carfentanil is the best immobilizing drug we have tested on moose, and the manufacturer has been encouraged to get the product on the market. Until that time, its use will be limited to experimental trials.

#### Radio Telemetry

The Ace bandage radio collars placed on moose in spring 1982 proved workable and effective (Schwartz et al. 1983). The collars were monitored into fall and lasted as long as the transmitters. None had fallen off or come apart by early October. The potential problem of the collars absorbing moisture was not serious. The collars dried very readily and did not create any problems of which we were aware.

The apparent success of our initial use of the Ace bandage radio collar in 1982 provided us the background to utilize the collars again in 1983. The only difference was that the radio transmitters sewn into the collar in 1982 were the ear tag type design modification for model S2B5 (Telonics, Inc., Mesa, Ariz.) and in 1983 the transmitters were the model S2B5, unmodified.

### Late Breeding

All 5 females turned into the 4-ha pen with the 2 mature bulls conceived. Birth dates, sex, birth weight, disposition, and interval of turn-in to birth for the calves were recorded (Table 2). The 1st 2 cows to calve produced twins. Angel had a prolonged birth and ruptured her fetal membrane (broke her water) approximately 36 hours prior to birth. One calf was stillborn and the other weak at birth. It died within 24 hours. The stillborn calf weighed 12 kg and the live calf 10 kg. Birth weight from 7 previous MRC tame moose were considerably greater ( $\bar{x} = 15.3 \pm 1.9$  kg) (Table 3) than Angel's calves in 1983. Mean weights from 9 free-ranging calves captured on the Kenai Peninsula in May 1977 within 72 hours of birth was 17 kg. (Franzmann and Schwartz 1978). In 1978, 6 calves also captured on the Kenai Peninsula within 48 hours of birth had mean weight of 14.9 kg (Regelin et al. 1979). Swedish moose gestation period was reported as varying between 226 and 244 days, with 75% calculated to fall between 232 and 238 days and a mean of 234 days (Markgren 1969). Peterson (1955) reported the gestation period for North American moose to range from 240 to 246 days. Angel's gestation period, if she were bred the day she was turned out, would have been only 226 days. The small, weak calves and the short gestation period indicate that Angel's calves were premature.

Jezebel also had twin calves (Table 2), but 1 calf was mummified and weighed only 5 kg. The other calf was healthy and weighed 13 kg.

Trixie, Lucy, and Oly all had single calves born in mid-June. All calves were healthy and weighed 14, 19, and 15 kg, respectively. Trixie's calf died from a Clostridium type infection that entered via the umbilicus.

In general, late breeding of the tame moose in fall 1982 resulted in all animals reproducing, but with somewhat varying results. The 3 single calves born 15 to 17 June can be considered as reflecting late breeding. Jezebel's calving (twin calves born on 7 June 1983) may not reflect late breeding as much as shortened gestation associated with twinning. There is very little evidence in wild ungulates to prove that the gestation period for twins calves is shorter, but data from the MRC do suggest the possibility (Tables 2, 3). Shorter gestation for twin calves has been recognized in the veterinary literature for domestic cattle for many years (Craig 1912).

The mummified fetus from Jezebel was not the first we have witnessed at the MRC. In 1982, a mummified fetus was expelled by Angel. Mummification of the fetus is caused by separation of the fetal membranes from the uterus. Uterine fluids are absorbed, and the uterus contracts around the desiccated fetus (Gibbons 1963). For mummification to occur, it is necessary that the uterus not become invaded with putrefactive organisms, and this is dependent on the cervix remaining sealed and closed (Benesch and Wright 1952). Mummification is a relatively common occurrence in dairy cattle (Benesch and Wright 1952).

### Snow Plots

Snow depth in various habitat types at the MRC have been summarized from winters 1970-1971 through 1982-93 (Tables 4, 5, and 6). Snow depths were less in vegetation types with greatest amount of overstory (dense hardwoods, mature spruce) and conversely greater in thin overstory plots (sedge, birch-spruce [thin], spruce-ledum, and rehab area). Coady (1974) indicated that snow up to 40 cm causes little or no hindrance to moose movement. From 40 to 70 cm, movement is slightly restricted, but at depths greater than 70 cm movement is impeded. Snow depths over 70 cm were attained during February 1978 (birch-spruce [thin], birch spruce [thick], spruce-ledum, mature spruce, and rehab plots), during December 1978-January 1979, (birch spruce [thin], birch-spruce [thick], spruce-ledum, and rehab plots), and during February 1980 (spruce-ledum) (Table 6). Snow was not persistent during these winters, and they were not considered severe winters for moose survival.

Snow accumulation did not exceed 40 cm during winters of 1975-76, 1976-77, 1980-81, and only for a short time during winters 1981-82 and 1982-83. Essentially, since winter 1975-76 to the present, the winters at the MRC (based upon snow depth and persistence of snow) have been relatively easy for moose (Tables 5, 6). Conversely, difficult winters based on snow depth and persistence were experienced during winters 1971-72, 1972-73, and 1974-75 (Tables 4, 5). Winters 1970-71 and 1973-74 may be considered moderate for moose.

Basing severity on depth alone may not be meaningful, and adding persistence provides a better assessment. However, other qualities of snow are important and include density, hardness, and temperature. Hardness is the most critical factor following depth since it represents the force that must be exerted to move legs or body through snow (Coady 1974). Good measures of hardness were not made at the MRC, so we must depend upon depth and persistence records. Most importantly, we can measure survival of calves through winter. The only winters where deaths of calves and some subadults could be basically attributed to winter severity were winters 1971-72, 1972-73, and 1974-75

(LeResche et al. 1973; Franzmann and Arneson 1974, 1975). Calf survival information coincides with snow depth and persistence data from the MRC, i.e., during winters of 100% calf mortality at the MRC, the snow was over 40 cm deep in most plots for considerable time periods (Tables 4, 5).

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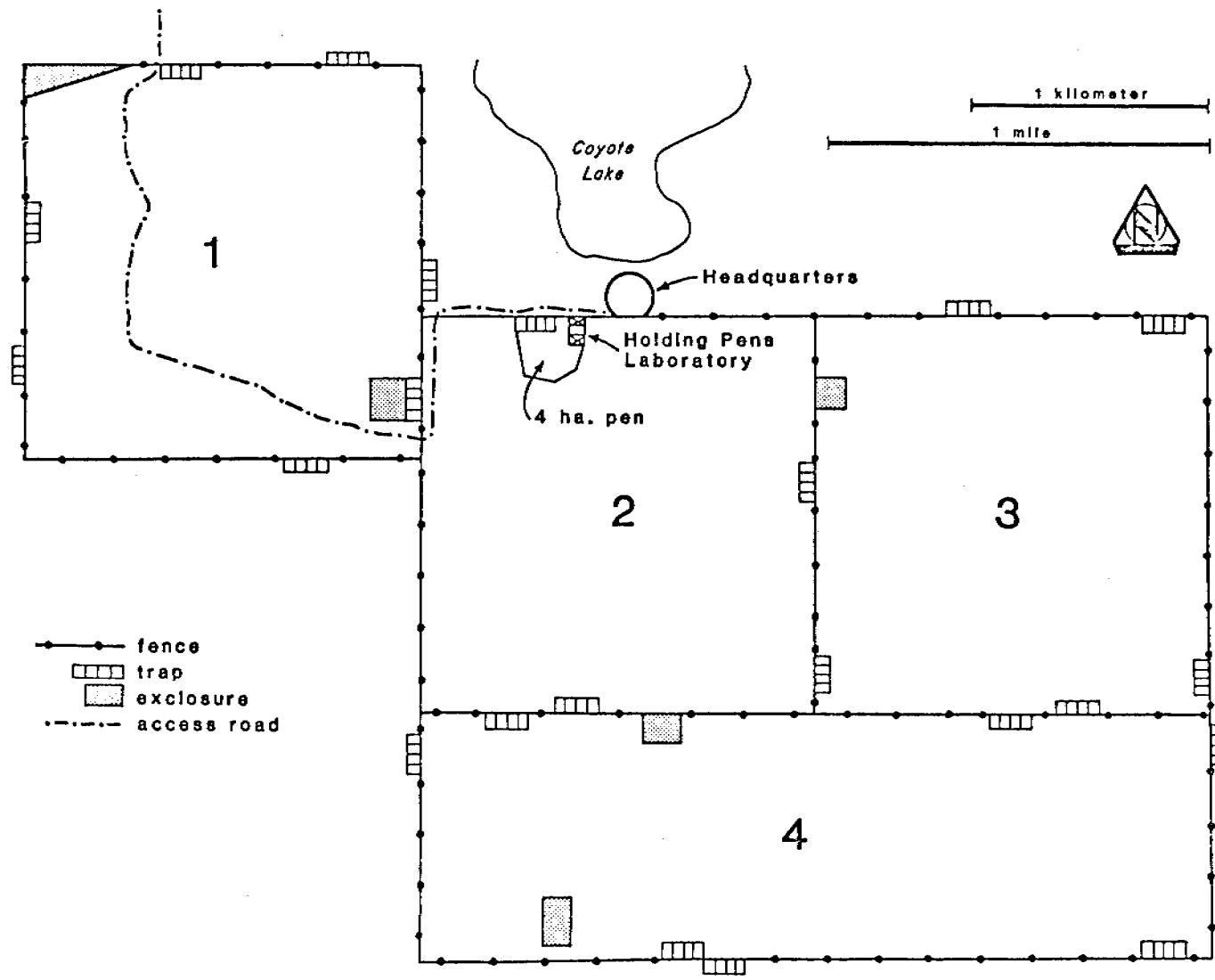


Fig. 1. Moose Research Center enclosures.

Table 1. Data on Carfentanil-immobilized adult Alaskan moose, March 1983.

Moose No.	Sex	Weight <sup>a</sup> (kg)	Total dose (mg)	Dose/kg	Down time		Time down (Min)	Up time		Comment
					Min	Sec		Min	Sec	
1	F	379	4.0	.011	3	30	20	4	0	
2	F	385	4.0	.010	3	14	25	4	2	
3	F	371	4.0	.011	6	21	16	5	26	
4	F	365	4.0	.011	3	57	19	5	34	
8	F	358	4.0	.011	4	0	22	--	--	
9	F	392	4.0	.010	6	30	31	6	20	
10	F	365	4.0	.011	4	40	23	3	40	
11	F	365	4.0	.011	6	23	39	3	30	
12	F	396	4.0	.010	4	3	21	4	29	
13	F	402	4.0	.010	5	2	19	3	20	
14	F	334	4.0	.012	4	0	16	3	30	
15	F	323	4.0	.012	3	44	21	6	31	
17	F	328	4.0	.012	4	31	26	--	--	2nd dart
25	F	354	4.0	.011	7	30	18	4	0	
43	M	375	4.0	.011	3	30	18	9	0	
Mean		369	4.0	.011	4	44	22	4	52	
7	F	336	3.0	.009	6	30	29	2	0	
19	F	392	3.0	.008	4	10	--	--	--	
20	F	381	3.0	.008	--	--	--	10	7	2nd dart
21	F	365	3.0	.008	8	55	31	3	30	
22	F	371	3.0	.008	3	10	34	9	35	
23	F	361	3.0	.008	6	30	18	2	0	
97	M	385	3.0	.008	4	3	22	5	13	
98	M	354	3.0	.008	4	20	15	4	0	
99	M	381	3.0	.008	4	20	19	6	0	
Mean		369	3.0	.008	5	15	25	5	18	
5	F	354	2.5	.007	9	30	--	--	--	2nd dart
18	F	334	2.5	.007	8	30	19	15	0	2nd dart
24	F	392	2.5	.006	10	20	31	4	0	
28	F	313	2.5	.008	18	0	26	8	54	2nd dart
30	F	348	2.5	.007	4	30	19	4	30	
77	M	392	2.5	.006	3	18	24	--	--	
37	F	342	2.5	.007	4	0	18	2	0	
33	F	385	2.5	.006	4	0	23	3	30	
Mean		358	2.5	.007	7	46	23	6	17	

<sup>a</sup> Weight calculated from regression equation from total length measurement.  
 Weight (kg) =  $-239.7 + 2.07$  (total length) from Franzmann et al. (1978).

Table 2. Birth dates, weights of calves, and interval between turn-in (15 Oct 1982) and birth of tame moose at Moose Research Center.

Adult female	Birth date	Sex	Birth weight (kg)	Disposition	Interval from turn-in (days)
Angel	28 May 1983	F	12	Stillborn	226
			10	Died in 24 hours	226
Jezebel	7 Jun 1983	M	5	Mummified fetus	236
		M	13	Live healthy calf	236
Trixie	15 Jun 1983	M	14	Live healthy calf; died 19 Jun of <u>Clostridium</u> infection	244
Lucy	17 Jun 1983	F	19	Live healthy calf	246
Oly	17 Jun 1983	F	15	Live healthy calf	246

Table 3. Birth weights of calves born to Moose Research Center tame moose.

Adult female	Birth date	Sex	Weight (kg)
Raquel	11 Jun 1973	M	14.5
Raquel	20 May 1975	M	13.6
		F	12.7
Angel	17 May 1981	F	16.0
Jezebel	21 May 1981	M	17.0
Lucy	25 May 1981	M	18.0
		F	15.0
Weight $\bar{x}$ = 15.3, SD = 1.9			

Table 4. Snow depths (cm) of Moose Research Center, Alaska; snow plots in various habitat types from winters 1970-71 through 1972-73.

Date	Plot 1, dense hardwood	Plot 2, thin hardwood	Plot 3, sedge	Plot 4, spruce regrowth	Plot 5, birch- spruce (thin)	Plot 6, birch- spruce (thick)	Plot 7, spruce- ledum	Plot 8, mature spruce
24 Feb 1971	7	19	13	19	20	28	28	10
4 Mar 1971	27	38	33	39	43	50	48	26
12 Mar 1971	33	47	41	44	51	60	56	27
24 Mar 1971	24	45	27	44	39	47	44	25
31 Mar 1971	22	39	32	29	38	36	41	19
13 Apr 1971	13	30	22	15	33	25	36	15
20 Apr 1971	13	18	13	14	22	22	28	10
5 Nov 1971	11	13	13	14	17	13	--	8
12 Nov 1971	11	15	18	18	16	13	9	8
19 Nov 1971	9	13	12	13	13	11	--	5
24 Nov 1971	11	15	16	15	15	13	6	6
3 Dec 1971	15	19	20	20	22	17	10	9
9 Dec 1971	18	24	50	25	23	24	13	13
16 Dec 1971	29	33	37	39	37	33	14	23
23 Dec 1971	29	33	34	36	32	29	19	23
5 Jan 1972	33	36	44	46	43	43	46	26
19 Jan 1972	32	32	29	46	43	46	39	24
25 Jan 1972	32	34	27	45	43	39	24	
2 Feb 1972	47	34	43	58	62	55	57	36
8 Feb 1972	44	52	42	57	58	56	56	35
20 Feb 1972	42	52	41	57	58	56	57	35
28 Feb 1972	40	50	38	55	55	50	53	34
7 Mar 1972	40	50	39	57	51	51	56	33
14 Mar 1972	45	56	43	60	56	51	61	34
20 Mar 1972	42	57	44	58	55	53	60	36
28 Mar 1972	38	51	38	54	51	47	56	30
5 Apr 1972	46	58	43	62	58	53	58	36
11 Apr 1972	44	55	44	61	57	52	60	33
19 Apr 1972	44	56	46	60	56	57	67	30
27 Apr 1972	36	42	33	47	47	39	51	26
30 Nov 1972	13	17	17	16	17	15	16	11
7 Dec 1972	11	15	16	15	15	13	16	10
13 Dec 1972	12	15	16	15	16	15	15	12
20 Dec 1972	13	16	18	19	16	17	17	10
28 Dec 1972	12	16	18	18	16	16	17	10
3 Jan 1973	27	33	34	35	37	31	34	26
10 Jan 1973	25	34	34	34	35	34	34	24
17 Jan 1973	28	32	32	32	32	30	31	20
26 Jan 1973	24	29	36	35	36	34	34	23
31 Jan 1973	36	46	48	52	49	46	51	31

Table 4. Continued.

Date	Plot 1, dense hardwood	Plot 2, thin hardwood	Plot 3, sedge	Plot 4, spruce regrowth	Plot 5, birch- spruce (thin)	Plot 6, birch- spruce (thick)	Plot 7, spruce- ledum	Plot 8, mature spruce
7 Feb 1973	34	44	46	51	46	49	50	32
14 Feb 1973	35	48	47	49	45	48	50	30
21 Feb 1973	32	48	45	48	45	47	49	24
28 Feb 1973	34	47	43	45	45	47	50	23
7 Mar 1973	33	47	45	48	47	47	51	26
15 Mar 1973	40	53	53	53	50	55	60	31
21 Mar 1973	36	49	50	44	52	48	57	27
28 Mar 1973	25	38	36	39	38	35	40	23
4 Apr 1973	19	24	22	26	30	34	23	17
11 Apr 1973	0	12	Flooded	Trace	Trace	Trace	Trace	0

Table 5. Snow depths (cm) of Moose Research Center, Alaska; snow plots in various habitat types from winters 1973-74 through 1976-77.

Date	Plot 1, dense hardwood	Plot 2, thin hardwood	Plot 3, sedge	Plot 4, spruce regrowth	Plot 5, birch- spruce (thin)	Plot 6, birch- spruce (thick)	Plot 7, spruce- ledum	Plot 8, mature spruce	Plot 9, rehab area
28 Nov 1973	15	20	23	23	23	23	23	13	
19 Dec 1973	14	16	22	19	19	19	19	12	
28 Dec 1973	10	16	19	16	18	18	19	7	
3 Jan 1974	10	21	22	21	23	21	22	7	
25 Jan 1974	11	23	24	24	24	23	24	12	
8 Feb 1974	19	31	28	35	32	34	34	17	
14 Feb 1974	25	42	39	45	45	40	44	21	
22 Feb 1974	28	42	37	49	47	44	47	24	
1 Mar 1974	32	44	44	51	50	44	49	28	
21 Mar 1974	21	36	25	40	36	32	35	16	
2 Apr 1974	0	0	0	0	0	0	0	0	
4 Dec 1974	16	25	25	27	28	26	29	11	
12 Dec 1974	19	28	30	32	31	31	33	16	
18 Dec 1974	25	32	35	37	37	38	41	19	
30 Dec 1974	26	35	35	40	40	40	44	23	
15 Jan 1975	39	50	46	52	55	52	56	38	
22 Jan 1975	33	43	40	45	47	46	49	32	
5 Feb 1975	29	38	37	42	46	44	48	30	
20 Feb 1975	40	50	48	59	58	60	62	38	
27 Feb 1975	37	50	45	56	53	54	61	32	
11 Mar 1975	40	53	49	60	58	56	64	40	
21 Mar 1975	38	54	48	58	59	55	63	40	
4 Apr 1975	40	59	49	59	64	55	62	37	
21 Apr 1975	27	39	20	38	41	33	43	28	
25 Apr 1975	20	30	13	35	38	25	39	23	
6 Jan 1976	15	23	18	25	25	20	25	13	
22 Jan 1976	23	35	30	32	37	25	35	23	
30 Jan 1976	20	30	27	23	32	20	29	15	
12 Feb 1976	11	23	18	18	25	15	25	3	
16 Mar 1976	14	37	18	17	33	23	21	0	
4 Nov 1976	11	15	15	13	17	20	17	11	17
10 Nov 1976	14	20	10	19	21	26	18	12	21
18 Nov 1976	2	12	3	11	13	17	15	0	7
24 Nov 1976	0	12	3	11	13	17	13	0	6
3 Dec 1976	2	11	2	9	12	4	7	1	3
9 Dec 1976	8	9	11	19	16	12	7	11	
16 Dec 1976	12	20	18	19	25	20	20	10	20

Table 5. Continued.

Date	Plot 1, dense hardwood	Plot 2, thin hardwood	Plot 3, sedge	Plot 4, spruce regrowth	Plot 5, birch- spruce (thin)	Plot 6, birch- spruce (thick)	Plot 7, spruce- ledum	Plot 8, mature spruce	Plot 9, rehab area
23 Dec 1976	10	17	15	17	23	19	16	8	14
29 Dec 1976	9	16	13	15	22	19	20	8	14
6 Jan 1977	5	17	6	22	23	21	19	3	4
20 Jan 1977	0	17	7	22	24	21	17	0	5
27 Jan 1977	0	17	0	20	19	9	13	0	1
13 Feb 1977	2	17	4	22	23	11	11	2	4
4 Mar 1977	9	17	10	21	25	14	10	4	9
23 Mar 1977	11	20	12	24	28	23	14	11	13
30 Mar 1977	18	24	18	27	28	27	22	16	19



Table 6. Snow depths (cm) of Moose Research Center, Alaska; snow plots in various habitat types from winters 1977-78 through 1982-83.<sup>a</sup>

Date	Plot 1, dense hardwood	Plot 2, thin hardwood	Plot 3, sedge	Plot 4, spruce regrowth	Plot 5, birch- spruce (thin)	Plot 6, birch- spruce (thick)	Plot 7, spruce- ledum	Plot 8, mature spruce	Plot 9, rehab area	Plot 10, snow pillow
28 Oct 1977	5	8	18	19	19	19	18	19	22	
29 Dec 1977	20	22	30	31	33	31	31	33	32	
9 Feb 1978	59	51	57	64	70	79	83	74	77	
17 Mar 1978	23	31	42	42	51	54	60	40	56	
8 Dec 1978	20	25	35	36	43	48	52	47	52	
18 Dec 1978	42	49	66	59	85	80	70	60	59	
4 Jan 1979	42	44	66	58	83	74	77	60	72	
Feb 1979	40	4	60	51	80	67	69	60	63	
24 Nov 1979	21	23	26	22	25	36	38	23	24	
7 Dec 1979	13	14	30	24	30	36	33	20	29	
5 Feb 1980	19	28	49	32	63	55	72	30	56	
26 Feb 1980	10	13	44	20	48	48	62	35	47	
1 Nov 1981	10	17	13	15	18	17	17	9	18	14
9 Nov 1981	14	21	19	20	21	23	21	14	20	19
25 Nov 1981	20	30	27	32	33	35	31	15	30	27
9 Jan 1982	20	33	20	30	42	30	16	23	30	
8 Mar 1982	15	33	13	31	36	47	32	10	23	28
1 Nov 1982	8	12	8	--	17	21	18	6	16	12
10 Nov 1982	27	39	34	--	47	54	44	22	39	36
1 Dec 1982	23	38	32	--	45	51	45	22	38	37
30 Dec 1982	7	28	0	25	28	33	25	4	23	20
12 Feb 1983	3	36	7	31	32	48	34	3	22	26

<sup>a</sup> Winter 1980-81 was essentially an open winter; 10 cm was maximum snow depth in January but it melted by 1 Feb.

## Appendix A.

### FIELD VALIDATION OF A MOOSE CARRYING CAPACITY MODEL

Investigators: Wayne L. Regelin, Charles C. Schwartz, and Albert W. Franzmann

#### INTRODUCTION

Carrying capacity, the number of individuals a unit of land can support for a unit of time without deleterious effects, is a term commonly used by wildlife biologists. Quantification of carrying capacity has been elusive and meaningful application of the concept nebulous. Early attempts to measure ungulate carrying capacity were based on production and utilization of forage by herbivores. Since animal requirements for nutrients were not considered, biologists were unable to quantify carrying capacity.

Moen (1973), Robbins (1973), and Wallmo et al. (1977) advanced the concept of predicting carrying capacity based upon knowledge of nutrition, forage quality, and forage quantity. Many complex interactions between nutrient availability and animal requirements must be understood in order to determine carrying capacity. The desire to use this concept for moose on different ranges was the impetus for a study at the Moose Research Center (MRC) from 1977 to 1982. During this period, specific information was collected on nutritional physiology and nutrient requirements of moose. This information has been incorporated into a computer simulation model (Swift 1983) that estimates daily energy and nitrogen (N) requirements based on diet digestibility and N concentration. The model predicts daily forage intake and changes in lean body mass and fat reserves. It appears to provide accurate estimates of forage intake and changes in body weight.

Extensive data were collected on the seasonal quality of the plant species used by moose during this same time. Seasonal food habits of moose on the Kenai National Wildlife Refuge have been well documented by LeResche and Davis (1973) and Regelin (1978). Techniques were also developed to accurately sample forage density (Oldemeyer and Regelin 1980) and standing crop biomass (Regelin, data in file). These data can be incorporated into a forage supply model similar to the approach described by Hobbs et al. (1982). Potential carrying capacity can be calculated by combining the 2 models. Estimates of carrying capacity can be based on availability of digestible energy or crude protein; both procedures appear to produce "reasonable" figures. The next step is to validate the models through field tests to determine their accuracy and precision in predicting carrying capacity. That is the goal of this study.

## OBJECTIVES

Specific objectives of this study are to:

1. Predict carrying capacity within each pen at the MRC and stock moose in exclosures at appropriate levels.
2. Determine if the predicted levels of plant utilization are achieved by the selected stocking levels.
3. Determine if the simulation model accurately predicts the seasonal fluctuations in body weight.

## GENERAL APPROACH

Seasonal diet selection and diet quality within the pens will be based on empirical data collected by LeResche and Davis (1973), Regelin (1978), Oldemeyer et al. (1977), plus unreported data on nutritional quality and plant density collected within the pens by Regelin in 1981. Based on these data, the simulation model will predict the daily forage intake for a female moose weighing 395 kg in November (Franzmann et al. 1978). The daily intake values will be totaled to provide estimates of total food intake for a summer period (May 1-Sep 30), a winter period (Oct 1-Apr 30), and for the total year. These intake rates will be used to calculate stocking rate (together with forage biomass values) in each pen. Intake values will be adjusted following stocking, when the body weights of the moose are known because forage intake is a function of body weight.

Standing crop biomass of all forage species will be measured within each pen in late summer. The amount of forage available in the winter, assuming no snow cover, will be estimated by adjusting for leaf fall. The number of moose days required to utilize 30, 50, 75, and 100% of the CAG of paper birch (*Betula papyrifera*) during winter will be calculated using the forage intake levels estimated by the simulation model. The diet mix of moose will be restricted to 70% paper birch. This appears to be the maximum intake level of paper birch that moose can sustain without digestive upset based on food habits studies by LeResche and Davis (1973) and limited feeding trials with tame moose (data in file). Utilization rates will be randomly assigned to each pen. The appropriate number of moose will be placed in each pen in October. The exact level of expected winter utilization will depend upon the body weights of the stocked moose. Expected utilization of paper birch during the summer period will be calculated based on the number of moose in the pen and on summer intake rates.

Utilization levels of paper birch plants will be measured in each pen during late September and late April. Moose will be captured seasonally to obtain body weights and other indicators of physical condition. Reproductive success of all moose will be monitored.

## PROCEDURES

### Estimates of standing crop biomass

Each pen will be subdivided into 4 equal quadrants and at least 6 transects will be established to estimate shrub density and standing crop biomass (SCB) of forage. The starting point for each transect will be randomly located along the fence lines. All transects will be 800 m in length with 8 sampling points randomly located along each transect. Distances will be estimated by pacing and transect direction maintained by compass. Transects will run in cardinal directions perpendicular to the appropriate fence lines.

At each sampling point, a 1 x 5 m plot will be established. All birch, willow (Salix spp.) and aspen (Populus tremuloides) plants over 40 cm in height that are rooted within the plot will be counted. The plant of each of these species nearest the lower right-hand corner of the plot will be selected for measurement. Its height and stem diameter at 10 cm above the ground will be measured. All leaves and CAG twigs will be clipped by 3 height strata (0-40, 41-80, and 81-400 cm) and sacked separately. Plants with a circumference exceeding 16 cm will be excluded from density counts and clipping. Plant material over 400 cm in height will not be collected. The SCB of each shrub species in each plot will be calculated by multiplying the density times the weight. This measure of weight will be used to calculate the amount of shrub SCB in each pen.

A 20 x 50 cm subplot will be established in the lower right-hand corner of the plot. All lowbush cranberry (Vaccinium vitis-idaea), fireweed (Epilobium angustifolium, and rose (Rosa acicularis) within and overhanging the subplot will be clipped at ground level. All clipped plant material will be oven dried at 100° C for 48 hours and weighed.

All field data will be entered in an Epson 20 field computer as they are collected. Plant weight data will be entered into the computer twice each week as it is weighed. These data will be electronically transferred from the Epson 20 to a microcomputer daily. After the data from 6 transects in each quadrant have been collected they will be analyzed to determine the mean and variance of SCB for shrub CAG. This analysis will indicate if sampling more (and how many) plots is necessary to estimate SCB within 20% of the mean at the 80% confidence level. This procedure will permit us to concentrate our efforts in quadrants with the greatest variability and not waste effort sampling more intensively than necessary.

Total forage SCB in each pen will be estimated by combining estimates from each quadrant. This figure will be used to calculate winter carrying capacity after accounting for leaf fall and forb desiccation.

### Estimates of birch production and utilization

Production and utilization of CAG twigs on birch plants will be estimated on 10 randomly located transects within each quadrant. These transects will be the same length and direction as the transects used to measure SCB, they will not have the same starting points. Ten random points will be selected along each transect. At each point, a pin will be placed in the ground and the distance to the nearest birch and its nearest birch neighbor will be measured. This will permit an estimate of birch density near each tagged birch plant (Batchelor and Bell 1970) and we will be able to relate utilization to density. The birch plant nearest the pin will be permanently tagged and its height and circumference measured. In the fall after plant growth has ceased, the number of CAG twigs and the diameter of each CAG twig at the bud scale scar will be measured on all tagged plants. Concurrently, the CAG twigs from 400 untagged birch plants in each pen will be clipped at the bud scale scar. The diameter and dry weight of each clipped CAG twig will be measured. Twig weights will be estimated using the model developed by Oldemeyer (1981, p.29),  $\text{weight} = a + b_1 (\text{diameter}) + b_2 (\text{diameter})^2$ . The total CAG production of each tagged plant will be calculated based on this model. The average CAG production of birch plants estimated in this manner will be compared with values for the SCB of birch CAG by the procedures described in the section on estimating SCB.

Winter utilization on each tagged plant will be determined in late April, just prior to leaf burst. If a plant has been browsed by moose, the number of CAG twigs remaining will be counted. The diameter at point of browsing will be measured on all CAG twigs that were browsed. The twig weight regression model will be used to calculate the amount of CAG removed. If old growth was also browsed, the amount removed will be qualitatively estimated. The utilization level of each tagged plant will be expressed as (1) percentage of production removed, (2) percentage of CAG twigs browsed, and (3) percentage of plants browsed. Strong correlation exists between these 3 estimates of utilization (Oldemeyer 1981).

Utilization levels during the summer period will be determined by examining each tagged plant in the autumn prior to leaf fall. Only presence/absence of browsing will be noted. Utilization will be expressed as percentage of plants browsed.

The carrying capacity models will predict the utilization level of birch during summer and winter periods. Measurements will be made for 2.5 years in each pen. This will provide 16 data points to compare predicted versus measured levels of utilization. Chi-square analysis will be done to determine if the values are similar.

### Measurement of the stocked moose

Seasonal changes in the body weights and physical condition, as reflected by blood chemistry, will be monitored for all moose within the pens. The moose will be captured in fence line traps, or darted by helicopter, at approximately 3-month intervals beginning in November. All moose will be equipped with a radio collar so they can be located for capture and their survival periodically monitored for calculating moose days of use. The moose will be closely monitored in late May-early June to determine if they give birth. All calves that survive the summer will be removed from the pens in October. Only mature cows and 1 bull will be stocked in each pen during winter.

The simulation model will predict body weight for each moose on any date. The predicted weights will be compared with the measured body weights at each opportunity. Chi-square analysis will be done to determine if the values are significantly different.

### Effects of snow

Snow depth in each pen will be estimated by extrapolating from the depth measurements along a permanent snow course near the pens. Moose will be trailed periodically to measure their travel routes in relation to snow depth. Estimates of forage biomass will be adjusted based on snow depth and the amount of forage that occurs in each height strata. The simulation models will predict carrying capacity based upon changes in forage availability. If appropriate, the expected utilization of birch will be adjusted to reflect the influence of snow depth or forage availability.

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