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MOOSE RESEARCH CENTER REPORT

by

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Progress Report
Federal Aid in Wildlife Restoration
Project W-22-3, Job 1.28R and 1.31R

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PROGRESS REPORT (RESEARCH)

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Cooperators: Mike Hubbert, Institute of Arctic Biology, Univ. of Alaska, Fairbanks

Project No: W-22-3 Project Title: Big Game Investigations

Job No.: 1.28 R Job Title: Moose Nutrition and Physiology Studies

Period Covered: July 1, 1983-June 30, 1984

SUMMARY

Major studies conducted during this period at the Moose Research Center (MRC) involved refinement of a carrying capacity model. Nine moose were randomly assigned to one of 3 treatments and fed a pelleted diet either *ad libitum* or at 85% or 70% of *ad libitum*. Changes in weight, body fat, rumen turnover time, and metabolic rate were monitored. Animals on the 85% and 70% intake levels lost weight and body fat at a faster rate than animals eating *ad libitum*. Two animals, one each in the 85% and 70% intake treatments, lost 22-32% of their body weight and were returned to *ad libitum* before the trials terminated. Samples for radio-assay were prepared and analyzed for both water and rumen turnover studies, but data were not available for this report. Weight data from the captive moose herd, and data on life histories for the MRC enclosures are presented.

Key Words: moose, nutrition, physiology, productivity.

CONTENTS

BACKGROUND

Digestive physiology studies with captive moose (Alces alces) were initiated in 1979 (Franzmann and Schwartz 1979) as part of the moose productivity and physiology project outlined by Franzmann et al. (1976). The major goal of these studies was to develop a carrying capacity model for moose on the Kenai Peninsula. Background pertaining to this subject has been discussed (Franzmann and Schwartz 1979). In general, we were attempting to integrate information on the nutritional requirements of moose (Appendix A) with information on the nutrients supplied from the vegetation (Appendix B).

The program is twofold: (1) vegetative biomass and nutrient quality will be determined, and (2) moose nutrient requirements and digestive physiology will be measured. This report describes ongoing research into the nutrient requirements of moose. The overall objective of these digestive physiology studies is to obtain input data for use in a carrying capacity model. Major emphasis this year centered around testing the simulation model that has been previously developed (Swift 1983).

Part of the long-range objectives for research at the MRC involves the development and testing of a carrying capacity model for moose (Franzmann and Schwartz 1979). This carrying capacity model consists of 2 components, a submodel which simulates nutrient flows within the moose (Swift 1983), and a submodel which allocates available vegetation biomass and associated nutrients from a range or habitat to the moose.

The moose submodel was originally developed for elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) in Colorado (Swift 1983) and has been adapted to moose. The model basically simulates the flow of energy and protein through the ruminant system and predicts changes in lean body weight and fat weight based on energy and protein intake.

This ruminant submodel is an integral component of the overall carrying capacity model, and refinement and testing are major objectives of ongoing research at the MRC.

Body condition is central to the current concept of carrying capacity, and changes in total, lean and fat weight are integral components of the ruminant submodel. Weight change has been used as the indicator of energy or protein status and changes in weight reflect diet quality. Body composition of moose has received no attention to date. Since metabolic differences exist between moose and other domestic and wild ruminants, use of these data is questionable. Body composition is generally assumed to be the chemical composition of the animal's body, or the percentage of fat, water, protein, and ash. Absolute and relative magnitude of these components is indicative of the animal's nutritional state.

The relationship between fat and water content within the body, and their negative correlation, was first discovered by Pace et al. (1947). This relationship is quite useful in predicting the total fat content of the animal body. Pace et al. (1947) developed a mathematical relationship which shows that average water content of the fat-free mass is 72.6% and percent fat may be calculated by $\%\ \text{fat} = 100 - \frac{\%\ \text{TBW}}{0.726}$ where TBW is total body water. This relationship has led to the present conceptional model of body composition.

This generalized formulation has been used for a variety of domestic species. Robbins (1973) developed specific relationships between body composition components of white-tailed deer (*Odocoileus virginianus*): their relationship is between concentrations of water (x) and fat (y) in the ingestion-free body: $y = 79.98 - 1.0757x$.

Both relationships hold promise in predicting total fat reserves in moose, based upon quantification of total body water. Torbit (1981) compared body composition estimates of mule deer, based on total body water calculated chemically, with estimates based on tritiated water (THO). Estimates from THO for total body water were consistently lower than chemical estimates for this component; however, differences were small and strong statistical relationships existed. Current research at the MRC centers around estimates of body composition based on body water relationships. Additionally, studies to estimate minimum maintenance energy requirements, seasonal metabolic rates, changes in rumen flow and dry matter digestion are components of this study.

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 the usefulness of these baselines as indicators of nutritional and general condition status of moose.

To apply the above criteria to the state's various moose populations.

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

Experimental Methods

Nine moose, including 6 adult females and 3 males (2 yearlings, 1 adult), originating from a wild population in Alaska, were used as experimental animals. Animals were hand-reared as described by Regelin et al. (1978) and maintained on a special moose ration (Schwartz et al. 1980, 1984a).

Research trials began 21 November 1983 and continued through 22 April 1984, a period of time equivalent to winter in Alaska. Animals were assigned at random to 3 treatment groups defined by 3 different levels of energy intake. These treatments were assigned as *ad libitum* intake, 85%, and 70% of *ad libitum* intake, based on g intake:BW $^{0.75}$ so that 3 gradients of energy consumption could be monitored. It was our intention to simulate wintering animals on 3 types of winter range with high to low energy intakes. We expect these intake levels to cause minimal, moderate, and severe loss of body weight.

Feeding levels were determined by adjusting the 85% and 70% intake treatments to the *ad libitum* group on a weekly basis with a 1-week time delay. Initial levels were based on previous measurements of intake from past trials (Schwartz and Franzmann 1981, Schwartz et al. 1981). Moose were randomly assigned to each treatment except that 1 male was included in each group. Animals were held in individual isolation pens (2.5 x 13.0 m) and offered their allotment of feed once daily at 1000 hours; water and trace mineral salt were available *ad libitum*. Animals were weighed once a week. At 4-week intervals, animals were injected with tritium and placed in digestion cages for estimation of total body water. Body composition was estimated for all moose every month. Because of a limited number of digestion cages, 3 animals were tested weekly. The sampling design used was to estimate total body water in all animals from the *ad libitum* treatment in a single week. The 2nd treatment (85% *ad libitum*) was sampled the 2nd week, and the 3rd treatment (70% *ad libitum*) was sampled the 3rd week. When body water was estimated, each animal was given a deep muscle injection of 2 ml of a physiological saline solution containing 1 microcurie of tritiated water (THO) per gram. Injections were administered to undrugged animals while they stood on the scale for weighing. After injection, animals were moved to the digestion cages, but not locked in until 4-6 hours post-injection time. Urine samples were collected at approximately 12-hour intervals for 4 days. Collection trays were cleaned with water prior to each trial. At the conclusion of a trial, animals were returned to their individual isolation pens.

Urine samples were analyzed for THO according to the methods described by Holleman et al. (1982).

Rumen solid and liquid turnover rates were estimated at monthly intervals using radio isotopes of Chromium-51 EDTA and Ruthenium-103 chloride as described by Schwartz et al. (1981, 1982). Moose were given a single oral dosage 200 µC on a feed sample. The moose were given access to eat the sample for 15 minutes, after which it was removed. Fecal samples were collected at 2-hour intervals the 1st day and at 6-hour intervals for the following 2 days.

Resting metabolic rates and methane production were estimated over a 12-hour period using a metabolic chamber and methane analyzer previously described by Regelin et al. (1981).

Digestion of dry matter was estimated from fecal samples collected weekly, based on concentrations of chromic oxide as described by Streeter (1966).

Productivity and Mortality of MRC Moose

Mortality and natality within the MRC enclosures were assessed by ground observations, periodical aerial observations, and trapping.

Moose within the MRC enclosures were moved from 1 enclosure to another or released outside the enclosures in an attempt to obtain approximately the following numbers and distributions: Pen 1 (2 moose); Pen 2 (3 moose); Pen 3 (3 moose); and Pen 4 (2 moose). One moose from Pen 4 was to be removed on 1 February 1984. Moose were moved utilizing an etorphine (M99, Lemmon Company, Sellersville, PA) and xylazine hydrochloride (Rompun, Hauer-Lockhart, Shawnee, KS) mixture for initial immobilization of trapped animals. Each animal was routinely processed when immobilized (Franzmann et al. 1976). Numbers of moose were set to utilize approximately 34%, 77%, 59%, and 100% of the current annual growth of birch in Pens 1-4, respectively.

RESULTS

Intake trials were initiated on 21 November 1983 and continued through 22 April 1984, followed by 3 weeks of metabolic trials. Intake varied in the *ad libitum* treatment throughout the trial (Table 1, Fig. 1) but generally followed the intake pattern established from previous studies (Schwartz et al. 1984b, see also Appendix A). Two animals, one in the 85% group, and one in the 70% intake group, lost 31.7% and 22%, respectively, of their pretrial maximum annual weight. Both were bulls and had lost weight during the rut prior to the start of the trial. We put both animals back on full feed on 21 February, to prevent death (Tables 2 and 3). Animals in the 85% and 70% treatments lost weight at a faster rate than the control (Fig. 1).

Samples collected for both rumen and water turnover are currently being analyzed, so estimates of rumen turnover time and total body fat were not available for this report. Fecal samples for chromic oxide analysis have been collected and frozen, but will not be analyzed until August 1984 when laboratory time is available.

Productivity and Mortality of MRC Moose

Histories of individual moose through 30 June 1984 are listed in Tables 4-7. Mortalities are listed in Table 8. We experienced several break-ins this winter, especially into Pen 2. There was also some tagging mortality associated with a new test drug (see Techniques section of "Evaluating and Testing of Techniques for Moose Management" report). Moose numbers will be adjusted this fall in an attempt to control utilization of the various pens for carrying capacity studies.

Moose Weights

We are continuing to weigh the tame moose biweekly (Tables 9-10). Most weight data collected is being analyzed for a manuscript.

ACKNOWLEDGMENTS

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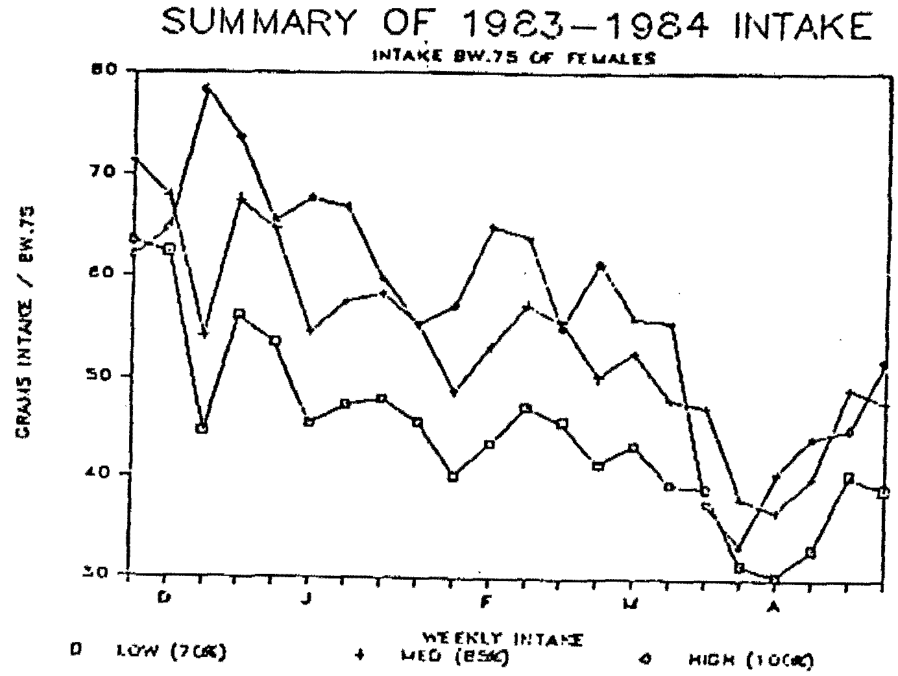

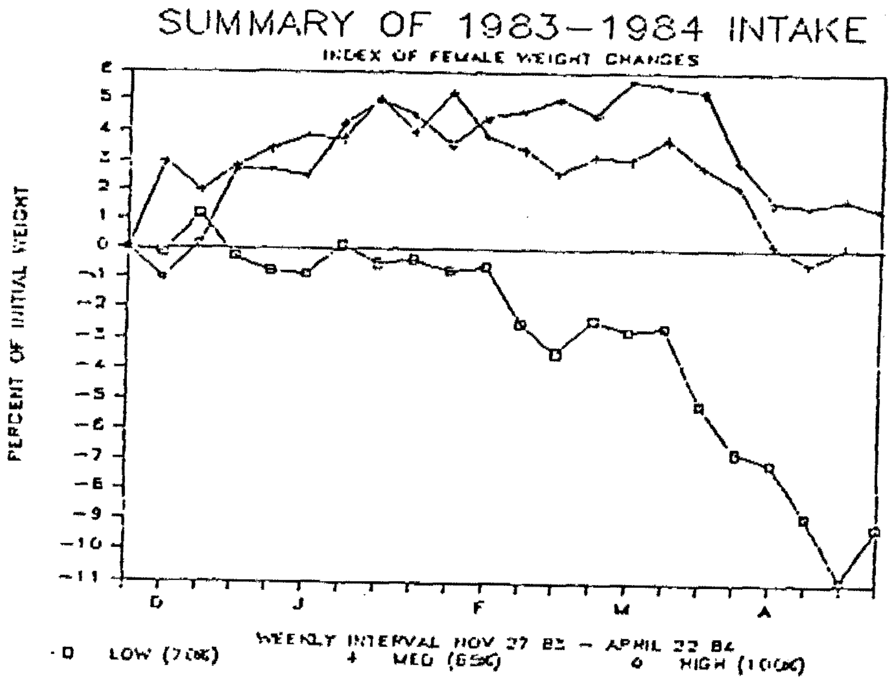

Fig. 1.

Dynamics of dry matter intake and percent weight change in female moose fed a pelleted diet at (1) ad libitum, (2) 85% and (3) 70% of ad libitum intake. Percent change was calculated as:

$$\frac{\text{Current weight - initial weight}}{\text{initial weight}} \times 100$$

Table 1. Weekly weight and intake of dry matter for 3 moose fed *ad libitum*.

	Charlie			Jezebel			Oly		
		Intake			Intake			Intake	
Date	Wt(Kg)	(g/d)	$BW^{0.75}$	Wt(Kg)	(g/d)	$BW^{0.75}$	Wt(Kg)	(g/d)	$BW^{0.75}$
11/27/83	340	4,860	61.38	480	6,195	60.41	437	6,093	63.75
12/4/83	327	5,378	69.94	469	6,800	67.47	439	5,957	62.11
12/11/83	331	6,930	89.31	480	8,245	80.40	439	7,305	76.17
12/18/83	345	6,701	83.76	491	7,871	75.46	451	7,022	71.75
12/25/83	343	5,184	65.04	492	6,476	61.99	450	6,761	69.20
1/1/84	344	5,846	73.19	487	7,075	68.25	453	6,576	66.97
1/8/84	346	5,740	71.55	502	6,805	64.17	454	6,853	69.67
1/15/84	346	5,499	68.55	497	6,499	61.74	466	7,198	71.77
1/22/84	346	5,185	64.63	491	5,056	48.47	468	6,265	62.27
1/29/84	349	5,844	72.38	485	5,312	51.40	465	6,285	62.76
2/5/84	353	5,805	71.28	490	6,478	62.20	468	6,813	67.71
2/12/84	348	5,843	72.52	487	6,905	66.60	473	6,218	61.31
2/19/84	350	5,576	68.91	491	5,399	51.76	473	5,893	58.10
2/26/84	355	5,406	66.10	488	6,441	62.03	471	6,144	60.77
3/5/84	353	5,226	64.17	496	5,611	53.38	474	5,954	58.61
3/11/84	355	4,351	53.20	496	6,353	60.44	472	5,125	50.61
3/18/84	342	5,089	63.99	495	3,157	30.09	471	4,592	45.42
3/25/84	346	5,435	67.74	479	3,648	35.63	466	3,142	31.32
4/1/84	345	5,458	68.15	474	4,608	45.36	458	3,551	35.87
4/8/84	357	6,292	76.61	477	3,952	38.72	454	4,900	49.82
4/15/84	364	6,744	80.93	479	4,416	43.13	454	4,642	47.20
4/22/84	367	6,447	76.89	478	5,519	53.99	452	4,889	49.87

Table 2. Weekly weight and intake of dry matter for 3 moose fed at 85% of *ad libitum* based on intake of moose in Table 1.

	Chief			Trixie			Lucy		
		Intake			Intake			Intake	
Date	Wt(Kg)	(g/d)	$BW^{0.75}$	Wt(Kg)	(g/d)	$BW^{0.75}$	Wt(Kg)	(g/d)	$BW^{0.75}$
11/27/83	502	7,794	73.49	446	7,739	79.74	461	7,100	71.36
12/4/83	507	6,951	65.06	468	7,337	72.91	466	6,808	67.88
12/11/83	500	5,743	54.31	459	5,396	54.41	466	5,443	54.27
12/18/83	510	7,209	67.17	465	6,741	67.31	468	6,795	67.53
12/25/83	502	6,948	65.51	464	6,516	65.17	474	6,579	64.76
1/1/84	498	5,770	55.02	466	5,455	54.38	476	5,565	54.61
1/8/84	501	6,084	57.45	460	5,760	57.99	481	5,904	57.48
1/15/84	495	6,115	58.27	466	5,842	58.24	487	6,042	58.28
1/22/84	493	5,796	55.39	460	5,508	55.45	483	5,715	55.46
1/29/84	486	5,055	48.83	467	4,903	48.81	488	5,064	48.77
2/5/84	479	5,445	53.17	461	5,292	53.19	481	5,463	53.18
2/12/84	485	5,896	57.05	460	4,233	42.61	478	5,851	57.23
2/19/84	467	5,580	55.54	458	5,298	53.52	473	5,634	55.54
2/26/84	466	7,472	74.50	460	4,995	50.28	476	5,121	50.25
3/5/84	467	7,599	75.64	462	5,238	52.56	473	5,337	52.62
3/11/84	455	10,014	101.6	466	4,766	47.52	475	4,887	48.03
3/18/84	454	10,344	105.1	465	4,702	46.96	468	4,747	47.18
3/25/84	446	8,955	92.27	463	3,807	38.14	464	3,816	38.16
4/1/84	463	11,009	110.3	455	3,638	36.93	454	3,629	36.90
4/8/84	482	11,003	106.9	453	3,948	40.20	450	3,930	40.22
4/15/84	493	9,696	92.67	456	4,850	49.15	452	4,814	49.11
4/22/84	483	9,746	94.59	455	4,686	47.56	452	4,685	47.80

Table 3. Weekly weight and intake of dry matter for 3 moose fed at 70% of ad libitum based on intake of moose in Table 1.

	Deneki			Angel			Joker		
		Intake			Intake			Intake	
Date	Wt(Kg)	(g/d)	$BW^{0.75}$	Wt(Kg)	(g/d)	$BW^{0.75}$	Wt(Kg)	(g/d)	$BW^{0.75}$
11/27/83	379	5,457	63.53	458	6,248	63.11	345	5,008	62.56
12/4/83	389	5,471	62.46	447	6,254	64.34	343	5,093	63.90
12/11/83	388	3,913	44.75	459	4,440	44.78	340	3,585	45.28
12/18/83	380	4,833	56.15	455	5,508	55.90	341	4,410	55.57
12/25/83	380	4,617	53.64	451	5,265	53.79	333	4,221	54.14
1/1/84	375	3,876	45.49	455	4,440	45.07	330	3,512	45.36
1/8/84	379	4,068	47.35	459	4,698	47.37	340	3,717	46.94
1/15/84	383	4,158	48.03	450	4,686	47.96	325	3,676	48.02
1/22/84	380	3,933	45.69	454	4,491	45.66	336	3,582	45.64
1/29/84	376	3,435	40.23	455	3,960	40.20	323	3,061	40.18
2/5/84	377	3,726	43.54	455	4,293	43.57	312	3,276	44.12
2/12/84	367	3,958	47.20	449	4,604	47.20	307	3,458	47.14
2/19/84	361	3,789	45.75	447	4,446	45.73	292	3,231	45.74
2/26/84	368	3,474	41.34	449	4,041	41.42	287	4,429	63.52
3/4/84	467	3,627	36.10	447	4,212	43.32	298	8,182	114.0
3/11/84	365	3,294	39.45	450	3,846	39.37	312	10,176	137.0
3/18/84	355	3,195	39.06	439	3,744	39.03	331	11,133	143.4
3/25/84	348	2,529	31.38	433	2,979	31.38	337	9,780	124.3
4/1/84	343	2,419	30.36	435	2,898	30.42	345	7,224	90.24
4/8/84	340	2,623	33.13	423	3,088	33.11	346	8,875	110.6
4/15/84	333	3,158	40.51	413	3,710	40.50	347	8,073	100.4
4/22/84	336	3,072	39.14	424	3,655	39.12	358	8,899	108.1

Table 4. Histories of Pen 1 moose at Kenai Moose Research Center (1 July 1983-30 June 1984).

Moose No.	Sex	Year of birth	Significant observations: Date	Event	Remarks	No. of times observed	No. of times captured
00-83(8)[a]	M	1978	15 Oct 83	Trapped	Released outside of pens. Radio collar removed.	7	2
30-83 (R70-8)[a]	F	1968	9 Nov 83	Darted	Radio-collared; moved to Pen 4 with helicopter.	6	1
37-83[a]	F	1980 or 81	20 Oct 83	Trapped	Released outside of pens. Radio collar removed.	4	1
29-83[a]	F	-[b]	10 Sep 83	Found dead	Last sighted when collared on 11 May 1983. Probably died shortly after that.	1	0
21-83[a]	F		9 Nov 83	Darted	Radio-collared; moved to Pen 3 with helicopter.	1[c]	1
23-83	F		7 Jun 84	Observed, no calf seen	Trapped and radio-collared on 20 Sep 1983.	5[c]	1
26-83	F		24 Jun 84	Observed with calf	Trapped and radio-collared on 10 Nov 1983.	6[c]	1

[a] Moose no longer living in this pen.
[b] Year of birth not known for all columns left blank.
[c] Moose may have been observed, but not identified, while still uncollared.

Table 5. Histories of Pen 2 moose at Kenai Moose Research Center (1 July 1983-30 June 1984).

Moose No.	Sex	Year of birth	Significant observations			No. of times observed	No. of times captured
			Date	Event	Remarks		
33-83[a]	F	-[b]	19 Oct 83	Trapped	Released outside of pens. Radio collar removed.	5	3
28-83[a]	F		2 Nov 83	Trapped	Released outside of pens. Radio collar removed.	8[c]	5
3-83[a]	M		20 Oct 83	Trapped	Released outside of pens. Radio collar removed.	5[c]	3
UC (20)[a]	F		1 Nov 83	Trapped	Caught and collared for 1st time 1 Nov 1983. Released outside of pens.	1[c]	1
31-83[a]	M		31 Jan 84	Found dead	Initially collared on 15 Dec 1983 (helicopter). Died between 20 and 27 Jan 1984. This moose broke into Pen 2 on 9 or 10 Dec 1983.	2	1
UC[a]	M		12 Apr 84	Carcass seen from air	This is probably the moose that broke into Pen 2 on 4 or 5 Feb 1984. Estimated death date is 31 Mar 1984.	1	0

Table 5. Continued.

Moose No.	Sex	Year of birth	Significant observations: Date	Event	Remarks	No. of times observed	No. of times captured
27-83	F	–[b]	29 Jun 84	Observed, no calf seen	Trapped and radio-collared on 14 Sep 1983.	7[c]	1
4-83	F		30 Jun 84	Radio signal heard	Trapped and radio-collared on 20 Sep 1983.	5[c]	2
UC	F		8 Jun 84	Observed with calf	Probably the only UC cow in Pen 2 after release on 1 Nov 1983. (UC) 20	6[d]	0

[a] Moose no longer living in this pen.

[b] Year of birth not known for all columns left blank.

[c] Moose may have been observed, but not identified, while still uncollared.

[d] This moose was observed 6 times after all other cows were collared.

Table 6. Histories of Pen 3 moose at Kenai Moose Research Center (1 July 1983-30 June 1984).

Moose No.	Sex	Year of birth	Significant observations: Date	Event	Remarks	No. of times observed	No. of times captured
24-83 (18)[a]	F	-[b]	13 Oct 83	Trapped	Released outside of pens. Radio collar removed.	5	4
1-83 (5)[a]	M	1974	15 Oct 83	Trapped	Released into Pen 4.	8	3
30-83[a]	M	1982	2 Nov 83	Trapped	Released outside of pens. Radio collar removed.	4[c]	2
UC (24)[a]	F		1 Nov 83	Trapped	Caught and collared for 1st time 1 Nov 1983. Released outside of pens.	1[c]	1
25-83 (17)[a]	F		1 Feb 84	Found dead	Fast radio signal indicated moose died about 15 Jan 1984. Possible wolf kill.	3[c]	1
22-83[a]	M		7 Nov 83	Found dead	First caught and collared on 6 Oct 1983. Probably died in October. Radio signal not heard on 26 Oct 1983.	3[c]	2

Table 6. Continued.

Moose No.	Sex	Year of birth	Significant observations			No. of times observed	No. of times captured
			Date	Event	Remarks		
20 (32)[a]	F	-[b]	18 Jun 84	Found dead	Last seen alive on 11 May 1983. Probably died before 31 May 1983, since she appeared to be in poor condition.	1	0
75 (15)[a]	F	1969	7 Jun 82	Last sighted, assumed dead	Not seen during 2 helicopter surveys in 1983.	0	0
21-83	F		30 Jun 84	Radio signal heard	Caught in Pen 1 on 9 Nov 1983 and moved to Pen 3 by helicopter.	0	0
UC	F		1 Feb 84	Observed	Probably the only UC cow in Pen 3 after UC (24) was released on 1 Nov 1983.	ND[d]	0

[a] Moose no longer living in this pen.

[b] Year of birth not known for all columns left blank.

[c] Moose may have been observed, but not identified, while still uncollared.

[d] Moose uncollared, number of sightings uncertain.

Table 7. Histories of Pen 4 moose at Kenai Moose Research Center (1 July 1983-30 June 1984).

Moose No.	Sex	Year of birth	Significant observations: Date	Event	Remarks	No. of times observed	No. of times captured
32-83 (670)[a]	F	1970	19 Dec 83	Radio signal changed to mortality mode.	Cow with old eartag was radio-collared on 15 Dec 1983. Probably died on 19 Dec 1983. Carcass found late in Dec 1983.	2	1
UC[a]	F	-[b]	11 May 83	Last sighted, assumed dead	Not seen during helicopter survey on 1 Nov 1983.	0	0
1-83 (5)[a]	M	1974	3 Dec 83	Found dead	Trapped and processed on 1 Dec 1983. Had been released into Pen 4 from Pen 3 on 15 Oct 1983.	3	2
30-83 (R70-8)[a]	F	1968	24 Feb 84	Found dead	Had been moved to Pen 4 from Pen 1 on 9 Nov 1983. Died on 23 or 24 Feb 1984.	2	1

[a] Moose no longer living in this pen.

[b] Unknown.

Table 8. Mortality within enclosures at Kenai Moose Research Center (1 July 1983-30 June 1984).

Pen No.	Moose No.	Sex	Year of birth	Date	Remarks
1	29-83	F	unk	10 Sep 83	Found dead. Last seen alive when drugged and collared on 11 May 1983. Probable drugging mortality.
1	UC	unk	1983	19 Jun 83	Last sighting of calf of 30-83 (R70-8). Cow seen without calf on 1 Jul 1983.
1	UC	unk	1983	24 Jun 83	Last sighting of calf of 37-83. Cow seen without calf on 11 Jul 1983.
2	31-83	M	unk	31 Jan 84	Moose initially collared on 15 Dec 1983, after breaking into Pen 2 on 9 or 10 Dec 1983. Died between 20 and 27 Jan 1984.
2	UC	M	unk	12 Apr 84	Carcass seen from air, later (17 Apr 1984) examined from ground. Moose broke into Pen 2 on 4 or 5 Feb 1984. Estimated death date is 31 Mar 1984.
2	UC	unk	1983	8 Jun 83	Only sighting of a 1983 calf in Pen 2. It was with one of several UC cows that were in Pen 2.
3	25-83 (17)	F	unk	1 Feb 83	Found dead. Last seen alive on 1 Nov 1983. Radio signal on mortality mode on 15 Jan 1984. Possibly killed by wolves. Wolves did feed on the carcass
3	22-83	M	unk	7 Nov 83	Found dead. First caught and collared on 6 Oct 1983. Radio signal not heard at MRC after 26 Oct 1983. Wolves fed on carcass, but mortality may have been drug-related.

Table 8. Continued.

Pen No.	Moose No.	Sex	Year of birth	Date	Remarks
3	20 (32)	F	unk	18 Jun 84	Found dead. Not a recent mortality. Appeared to be in poor condition when last seen alive on 11 May 1983. Probably died before 31 May 1983.
3	75 (15)	F	1969	7 Jun 82	Last sighted. Assumed dead. Not seen during 2 helicopter surveys in 1983.
4	UC	F	unk	11 May 83	Last sighted. Assumed dead. Not seen during helicopter survey on 1 Nov 1983.
4	1-83 (5)	M	1974	3 Dec 83	Found dead. Trapped and processed on 1 Dec 1983. Drugging mortality.
4	32-83 (670)	F	1970	19 Dec 83	Radio signal changed to mortality mode. Carcass found later in Dec 1983. Processed and radio-collared on 15 Dec 1983. Drugging mortality.
4	30-83 (R70-8)	F	1968	24 Feb 84	Found dead. Died on 23 or 24 Feb 1984. Had been moved to Pen 4 from Pen 1 on 9 Nov 1983.

Table 9. Weight (Kg) of tame moose.

	Chief	Rodney	Lucy	Angel	Jezebel	Trixie	Oly	Deneki	Joker	Charlie	Comments
1983											
July 5		598	440		467		368				
6	610					384			303	297	
8				417							
13			450		466		371				
15	628	603		422		387			320	306	
22			458		480		383				
26	625	616		429		406			327	319	
30			476		489		407				
Aug 6	647			438		416			350	323	
9			480		500		415				
15	653	663				418			349	333	
16				446							
19			492		508		423				
23	648				499						Jez and Hugo released in 15 acre pen.
25			483		504		429				Jez and Hugo confined on previous evening.
26				450		423				349	
27									367		
29		673									
30			491		509		426				
Sept 3	649										All bulls have shed velvet.
5				449		422				347	
6		648	487		516		432				
7	632	648			510				368	357	Antlers cut and hooves trimmed.
16	588		460	454	468	434	432		336	326	Calves (Lucy, Jez, Oly) weaned.
19	579		459	453	461	436	429		333	323	Joker turned out; all others given tritiated water.
23	566		459	457	457	431	429			310	Released after trial.

Table 9. Continued.

		Chief	Rodney	Lucy	Angel	Jezebel	Trixie	Oly	Deneki	Joker	Charlie	Comments
Oct	3				438	449		423				
	4			440						317	312	
	11						419			326	306	
	19			435	438	452	429	418	367		315	Lucy, Angel, Jez and Charlie given tritiated water.
	22								380			Lucy, Angel and Jez released.
	24			435	426	450					318	Charlie released after trial.
	25						439	422	376	326		Trixie, Oly, Deneki, and Joker given tritiated water.
	31						434	419	381	328		Released after trial.
Nov	11			449	440	466	446	430	379	343	335	
	21	502		461	458	480	446	437	379	345	340	Jez, Oly and Charlie given tritiated water.
	28	507		466	447	469	468	439	389	343	327	Chief, Lucy and Trixie given tritiated water.
Dec	5	500		466	459	480	459	439	388	340	331	Angel, Deneki, and Joker given tritiated water.
	12	510		468	455	491	465	451	380	341	345	
	19	502		474	451	492	464	460	380	333	343	Jez, Oly and Charlie given tritiated water.
	26	498		476	455	487	466	453	375	330	344	Chief, Lucy and Trixie given tritiated water.

Table 9. Continued.

	Chief	Rodney	Lucy	Angel	Jezebel	Trixie	Oly	Deneki	Joker	Charlie	Comments
1984											
Jan 2			481	459	502	460	454	379	340	346	Angel, Deneki, and Joker given tritiated water; moose wet.
3	501		482	464	498	463	459	384	336	345	Moose dry.
9	495		487	450	497	466	466	383	325	346	Crs, Ru 103 today.
16	493		483	454	491	460	468	380	336	346	Jez, Oly and Charlie given tritiated water.
23	486		488	455	485	467	465	376	323	349	Chief, Lucy and Trixie given tritiated water.
30	479		481	455	490	461	468	377	312	353	Angel, Deneki and Joker given tritiated water.
Feb 6	483		478	449	487	460	473	367	307	348	Off week.
13	467		473	447	491	458	473	361	292	350	Jez, Oly and Charlie given tritiated water.
20	466		476	449	488	460	471	368	287	355	Chief, Lucy, Trixie and Joker given tritiated water.
24	468		469			457			296		
27	467		473	447	496	462	474	367	298	353	Angel, Deneki given tritiated water.
Mar 6	455		475	450	496	466	472	365	312	355	Off week.
12	454		468	439	495	465	471	355	331	342	Jez, Oly and Charlie given tritiated water.
19	446		464	433	479	463	466	348	337	346	Chief, Lucy and Trixie given tritiated water.

Table 9. Continued.

		Chief	Rodney	Lucy	Angel	Jezebel	Trixie	Oly	Deneki	Joker	Charlie	Comments
Mar	21	443										Chief let out of stall; given antibiotic.
	22	456										
	26	463		454	435	474	455	458	343	345	345	Angel, Deneki, and Joker given tritiated water.
Apr	2	482		450	423	477	453	454	340	346	357	Turnover trial activity.
	4					468						Jez returned to pen from 15 acre pen.
	9	493		452	413	479	456	454	333	347	364	
	16	483		452	424	478	455	452	336	358	367	
	23	484		459	423	479	454	461	335	362	366	
	29			455	416							Chamber-Angel out; Lucy in.
	30	477		461	415	478	464	460	342	366	374	Lucy out of chamber; Jezebel in.
May	1								332			Jez out of chamber. Deneki in and out.
	2						450					Trixie in chamber.
	3						452	455				Trixie out of chamber; Oly in.
	4									357		Oly out of chamber; Joker in and out.
	5	467										Chief in chamber; (and out again).
	7	485		462	430	468	447	457	351	357	374	Charlie in chamber.
	9	482		466		471		452		366	372	All except Angel, Deneki, Trixie released from pens.
	14				427		457		353			Angel, Trixie, Deneki released.
	17	491		466	426	477	455	449	357	368	381	

Table 9. Continued.

		Chief	Rodney	Lucy	Angel	Jezebel	Trixie	Oly	Deneki	Joker	Charlie	Comments
May	21			467	433	480	451		364			
	26			471	442	482	392		370	384	396	First post-partum weight for Trixie.
	28	512										
	30			471	447	414	383					First post-partum weight for Jezebel.
	31								383	387	386	Joker and Charlie released into Pen 2.
June	1	511										Chief released into Pen 2.
	3						386					Trixie released into 15 acre pen with calf (Dos).
	4			467	446	392			371			Jezebel and her twins released into 15 acre pen.
	8			394								First post-partum weight for Lucy.
	12						388					Trixie turned out after calf was posted.
	14			375	454		386		389			
	15					378						
	19				459				385			
	20								363			First post-partum weight for Deneki.
	21				418					364		First post-partum weight for Angel.
	22			378	418				341			Deneki and Angel turned into 15
	24				383							acre pen.
	25								333			Deneki given 3rd injection of Combiotic.

Table 9. Continued.

	Chief	Rodney	Lucy	Angel	Jezebel	Trixie	Oly	Deneki	Joker	Charlie	Comments
June 26								339			Deneki's 4th shot. She retained her placenta.
27	487		388								
July 5					406						
6	505		381	418	397	401		326			
7	500		376		396			328			

APPENDIX A. Abstract of M. S. presented at 2nd International Moose Conf., Uppsala, Sweden

NUTRITIONAL ENERGETICS OF MOOSE

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Mike Hubber, Institute of Arctic Biology, University of Alaska, Fairbanks, Alaska 99701

NUTRITIONAL ENERGETICS OF MOOSE

SEND PROOF TO: Charles C. Schwartz, Alaska Department of Fish and Game, P. O. Box 3150, Soldotna, Alaska 99669

Abstract: Nutritional energetics of moose (Alces alces) are reviewed and discussed. Moose are classified as concentrate selectors, based on their digestive morphology, dietary selection, and rate of passage, Seasonal intake, which is a function of forage availability, digestibility and rate of passage varies seasonally with a low in late winter and a high in summer. Bulls fast for a period of 14-18 days during peak rut, while cows reduce intake, but do not fast. Rates of passage of food material through the gastrointestional tract varies with diet, and digestibility, and ranges from 21-34 hours for browse and 9-28 hours for hay and pelleted diets. Energy partitioning of moose foods indicates that approximately 25-75% of the gross energy intake is digestible. Significant correlations were established between dry matter digestion (DMD) and lignin content of the food, and between DMD and ash content of the food: DMD was also highly correlated with digestible energy (DE). Estimates of urine energy vary with diet, and protein content of the diet and range from 1.7-6.1% of gross energy (GE) intake. Methane production in moose ranges from 3.1-4.8% and is generally comparable to other ruminants. Estimates of metabolizable and net energy content of tested diets are presented and discussed. Basal metabolic rates of moose do not conform to the 70 $BW^{0.75}$ where BW is body weight, but vary seasonally with a high in summer and a nadir in late winter. Winter activity budgets for moose indicate that moose spend approximately 46% of their time feeding, with 5-6 feeding bouts per circadian cycle. Increments of various activities expressed as energy expenditure of the activity/energy expenditure of resting animal were 1.07, 1.08, 1.34, 1.29, and 1.66 for a bedded alert animal, bedded and ruminating, cratering, standing, and walking. Energy partitioning for moose consuming a pelleted diet, with known energetic loss is modeled to demonstrate the usefulness of nutritional energetics for moose management. Additional areas of needed research were presented and discussed.

Appendix B. Abstract of M. S. presented at 20th N. Am. Moose Conf.

SEASONAL DYNAMICS OF FOOD INTAKE IN MOOSE

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Albert W. Franzmann

Abstract: The seasonal dynamics of dry matter intake were measured with 12 tame moose (Alces alces) fed a pelleted ration from 1979-1983. Composition and digestibility of the diet were constant, so changes in dry matter intake reflect changes in physiological appetite of moose. Dry matter intake (DMI) paralleled seasonal changes in metabolic rates with peak consumption (116-142 g DMI/body weight (W)$^{0.75}$/day) occurring during summer months (June-September) with a nadir in late winter (50-59 g DMI/W$^{0.75}$/day), March-April. Complete fasting was observed in bulls during the rut and lasted as long as 18 days. Cows reduced intake during the breeding season (54-58 g DMI/W$^{0.75}$/day) to other studies where dry matter digestibility and rate of passage vary seasonally with diet quality.

ALCES VOL. 20:1984

PROGRESS REPORT

State: Alaska

Cooperators: None

Project No.: W-22-3 Project Title: Big Game Investigations

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

Period Covered: 1 July 1983-30 June 1984

SUMMARY

The experimental drug carfentanil (Janssen Pharmaceuticals, Beerse, Belgium) was tested on moose and findings were published. We also published our findings relative to monitoring vital signs of immobilized moose. Abstracts from both papers are contained in this report. Testing of the moose carrying capacity model was initiated at the Moose Research Center.

CONTENTS

BACKGROUND

The Moose Research Center (MRC), 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 1982 through 30 June 1983 was submitted and published (Franzmann et al. 1984a).

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 was obtained, and permission to test the experimental drug was done as per New Animal Drug (INAD) Permit No. 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 3 moose (Meuleman et al. 1984).

The MRC facility was used this past year for controlled testing of a moose carrying capacity simulation model. The background for this study was outlined (Regelin et al. 1984, Appendix A in Franzmann et al. 1984a).

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 testing on adult moose continued. Animals at 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).

Testing of Moose Carrying Capacity Model

Procedures for this study were outlined (Regelin et al. 1984, Appendix A in Franzmann et al. 1984a).

FINDINGS

Immobilizing, Reversing and Adjunct Drugs

Findings relative to testing carfentanil on moose were reported in Alces (Franzmann et al. 1984c). Appendix A is an abstract of that paper.

Monitoring vital signs (body temperature, heart rate, respiratory rate) in association with chemical immobilization of moose is an integral part of the capture/immobilization procedure. We reported our findings regarding baseline vital signs for moose and the factors which most affect them (Franzmann et al. 1984b). Appendix B is an abstract of that paper.

Testing of Moose Carrying Capacity Model

Findings from this study will be reported when the project is completed.

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APPENDIX A.

IMMOBILIZATION OF MOOSE WITH CARFENTANIL

Albert W. Franzmann, Charles C. Schwartz, David C. Johnson,
James B. Faro, and Warren B. Ballard

Abstract: From March 1983 through March 1984, 92 adult moose (Alces alces) were immobilized using Carfentanil. The concentration of the drug (10 mg/ml) allowed use of small volumes for injection, alleviating some problems associated with large volume dosages. Total dosage per moose varied from 2.5 to 5 mg Carfentanil (0.006 to 0.014 mg/Kg). Mean induction time for moose receiving at least 3 mg was 5.0 minutes (SD = 2.1, n = 7.5). Diprenorphine (M50-50) was used as the antagonist. During 1983, generally 14 mg were given intravenous (IV) and 6 mg intramuscular (IM). In 1984, the anagonist dosage was increased and generally 20 mg were given IV and 10 to 20 mg IM and 3 moose were givin 30 mg IM only. Mean recovery time was 4.2 minutes (SD = 1.9, n = 52). Hyperthermia, acute capture myopathy and/or narcotic recycling were attributed to 6 mortalities (6.5%) directly associated with immobilization. Causes of mortality and ways to minimize it were discussed.

ALCES VOL. 20:1984

APPENDIX B.

Baseline Body Temperatures, and Respiratory Rates of Moose in Alaska

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Abstract: Baseline body temperatures (BT), heart rates (HR), and respiratory rates (RR) were obtained from Alaskan moose (Alces alces gigas Miller) at the Moose Research Center (MRC), Alaska. Excitability, seasons, and drugs influenced the values to varying degrees. Excitability was the most influential factor. Safe expected ranges were: BT 38.4 to 38.9 C; HR 70 to 91 beats/minute (b/min); and RR 13 to 40 respirations/minutes k(r/min). These ranges incorporated all seasons, a central nervous system depressant drug, and a paralyzing drug. Values which may be considered critical and an indication that corrective action should be taken include: BT, 40.2C; HR, 102 b/min; and RR, 40r/min. It is recommended that persons trained in monitoring vital signs be on hand during moose capture and immobilization procedures.

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