

file
ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA

BEHAVIOR AND SURVIVAL IN ORPHANED MOOSE CALVES

By David C. Johnson,
Paul D. Arneson and
Albert W. Franzmann



STATE OF ALASKA
William A. Egan, Governor

DEPARTMENT OF FISH AND GAME
James W. Brooks, Commissioner

DIVISION OF GAME
Frank Jones, Director
• Donald McKnight, Research Chief

Final Report
Federal Aid in Wildlife Restoration
Project W-17-4, Job 19.9R and
Project W-17-5, Job 1.10R

Printed August 1973

FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: Bureau of Sport Fisheries and Wildlife, Kenai National
Moose Range

Project Nos: W-17-4 & W-17-5 Project Title: Big Game Investigations

Job Nos.: 19.9R & 1.10R Job Title: Behavior and Survival
in Orphaned Moose Calves

Period Covered: October 1, 1972 to June 30, 1973

SUMMARY

Ten cow moose with their calves were within the enclosures of the Kenai Moose Research Center through the winter of 1972-73. Six of these cows calved within the pens and the other four were introduced into the pens with their calves in the fall of 1972. In addition four orphan calves were introduced into the pens. Radio-collars were placed on six calves and six cows to facilitate tracking and subsequent observations pertaining to orphan and nonorphan survival, mortality, feeding and behavioral patterns.

Calf mortality was 100 percent. No specific pattern of time of death relative to orphan or nonorphan calves was noted. Snow condition (depth and hardness) and time of occurrence with lowered availability of food were the dominant mortality factors; however, the influence of introduction and retention in the pens, individual behavioral patterns and harassment were considered possible contributing causes. All calves appeared to have ultimately died from malnutrition.

The importance of nonbrowse food availability was noted in that 20.5 hours of observation time were devoted to digging craters for low-bush cranberry (*Vaccinium vitis-idaea*) while 30.8 hours of observation time were devoted to browsing.

CONTENTS

Summary	1
Background.	1
Objectives.	2
Procedures.	2
Survival and Physical Condition.	3
Mortality Factors.	3
Behavioral Patterns.	3
Feeding.	4
Comparative Analysis	4
Findings.	4
Cow/Calf Winter Relationships.	4
Factors Possibly Influencing Separation and Mortality.	17
Orphan Calves.	23
Recommendations	31
Literature Cited.	32

BACKGROUND

Proper management of moose (*Alces alces*) populations requires harvesting of females as well as bulls. Calves orphaned when their mothers are taken by hunters may present special management problems. If survival or physical condition of calves is influenced by the presence of the mother during the winter, hunting regulations may have to be modified to take this into consideration. The importance of the mother can best be determined by making winter observations of cows with calves. The Kenai Moose Research Center offers a fine opportunity for these observations since moose are enclosed and repeated observations of the same animals are possible.

There is widespread belief that calves are very dependent on their mothers for winter survival. This belief seems to be based on limited and scattered bits of evidence rather than on prolonged observations of cows with calves. The importance of the mother probably depends on several variables such as snow depth, food availability and moose densities.

Based on her work in Wyoming, Altmann (1958) stated that moose calves without mothers rarely survive the winter. Orphaned calves which do survive until spring may be in poorer condition than calves with mothers and therefore be more subject to mortality due to disease, accidents or predation. However, several moose populations have been successfully established in Alaska by transplanting calves without mothers in late summer (Burris and McKnight, in press).

In deep snow conditions, calves may expend more energy in moving between feeding areas if unable to follow mother's tracks. Where moose densities are high, lone calves may be driven out of optimum areas. In a study of Wyoming moose, Houston (1968) found that females with calves showed aggression toward all other sex and age classes during winter periods. This behavior resulted in the segregation of females with calves on winter ranges. Since winter range was limited, the more

aggressive females might be more successful than others in bringing calves through the winter.

Abandonment of calves by their mothers may occur during severe winters. General observations of moose calves on the Kenai National Moose Range during the winter of 1971-72 seemed to indicate more lone calves than could be accounted for by hunter-killed cows. Several groups of calves without adults were also observed. In the town of Soldotna, mixed groups of moose were observed which consisted of cows, calves and bulls. It was usually not possible to distinguish cow-calf pairs in these groups.

In Pen No. 3 at the Kenai Moose Research Center (MCR), a cow and calf are known to have become separated during the 1971-72 winter. They were seen together in mid-December. In mid-February, the calf was located and observed for several hours on different days over a week-long period. It then died, apparently of malnutrition. During the time it was observed, no other moose were seen near the calf and the mother was assumed to be dead. However, on March 23, 1972, the cow was observed and has been seen a number of times since that date.

During severe winters in Alaska, lone calves are often seen along roads and near dwellings. Many of these calves weaken and die. The common belief seems to be that these calves are unable to survive because their mothers have been killed during hunting season. It is possible that some of these calves are not orphans, but have been abandoned by their mothers. Under severe winter conditions, the calf may become weak and unable to keep up with the cow. Equally, the calf may be deserted as the mother moves to a new feeding area.

OBJECTIVES

To assess survival rate, physical condition, and causes of mortality of moose calves orphaned at various times in the fall and winter; to compare this information with survival, condition and causes of mortality of calves having mothers.

PROCEDURES

This study, initiated as Job 19.9R, was conducted at the Kenai Moose Research Center during the fall of 1972 and the winter of 1972-73.

On September 18, 1972, trapping of cows with calves from the area outside the pens began and by November 11, 1972, four cows with calves were introduced into Pen 4. Both mother and calf were equipped with radio-collars in two cases. One of the other cows had a radio as did one other calf. The advantages of using radios for mortality and behavior studies have been demonstrated (Berg and Phillips, 1972; Goddard, 1970; LeResche and Davis, 1971; and Van Ballenberghe and Peek, 1971). All mothers and calves were marked.

Six calves were born inside the moose pens in the spring of 1972. One calf was born in Pen 1, four calves were born in Pen 2, and one calf was born in Pen 4. On October 12, 1972, one of the Pen 2 calves escaped into Pen 1 with its mother. The Pen 4 calf was not seen after October 20, 1972, and was assumed to have died. Before winter, two of the cows were equipped with radios. All of the cows and two of the calves were marked.

Prior to the winter months, Pen 1 had two cow/calf pairs. Pen 2 had three cow/calf pairs, and Pen 4 had the four cow/calf pairs that had been introduced from outside the pens.

Survival and Physical Condition

Calves and cow/calf pairs were observed on a daily basis dependent upon availability of each. Consequently some individuals were observed more frequently than others. Activity, behavior and condition of observed moose were noted and dates of separation and mortality were recorded. The moose were located by one of the following methods:

1. Tracking with radio receiver;
2. Sighting from ground and tracking in snow cover;
3. Aerial sightings.

Mortality Factors

When a dead calf was located, the following procedure was used:

1. Investigate events prior to death;
2. Autopsy the calf when possible;
3. Collect hair and femur samples.

Behavioral Patterns

Types of observations that were emphasized are:

1. Social Interactions
 - a. frequency of contact
 - b. type of contact
 - c. description of animal or group contacted
2. Activity Patterns
 - a. feeding
 - b. resting
 - c. movements

Feeding

An attempt was made to determine what vegetation was used by the calves by:

1. Rumen analysis on dead calves;
2. Identification of plants after observed calf feeding;
3. Locating calf and back-tracking in snow to determine what plants had been used.

Comparative Analysis

Survival and behavior of orphaned calves were compared to:

1. Survival and behavior of all calves at MRC;
2. Survival of calves outside enclosures;
3. Survival and behavior of calves at MRC with mothers.

FINDINGS

Cow/Calf Winter Relationships (Survival, Mortality and Behavioral Patterns)

Pen 1

Cow No. 10 had a calf which was born in this pen. The cow was not equipped with a radio and was not often seen. Her calf was last seen with her on November 15, 1972 (Table 1).

Cow No. 76 was radio-tracked several times (Table 2). Her calf seemed to be very wary and was usually seen only briefly or not at all. Even when the calf was near the cow while the cow was being observed, the calf often remained hidden from view.

Neither of the Pen 1 calves was marked. Lone calves were sighted on January 22 and on February 16, 1973, but their identity could not be determined. Neither of the cows was seen with a calf after January 2, 1973. At least one of these cows separated from her calf. It is possible that the other calf died before the mother was first seen alone.

Pen 2

One cow/calf pair (R70-7 and uncollared female calf) remained together until the calf died between March 8 and March 11, 1973 (Table 3). Although this cow did not have a radio, she was very calm and was often snow-tracked and observed. When the calf was approached by the observer, she often moved nearer to her mother. However, on three occasions when the observer was standing, the calf approached to within 10 meters and one time was within 5 meters of the observer. R70-7 seemed

Table 1. Observations of cow No. 10 and uncollared calf in Pen 1.

[illegible]

Table 2. Observations of cow No. 76 and uncollared calf in Pen 1.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
6/20/72	-	-	-	-	-	-	Calf first seen (born in Pen 2).
8/4/72	-	-	-	-	-	-	Cow trapped, calf not seen.
9/6/72	-	-	-	-	-	-	Cow seen with calf (Pen 2).
9/17/72	-	-	-	-	-	-	Cow seen with calf (Pen 2).
10/12/72	-	-	-	-	-	-	Cow and calf broke into Pen 1.
10/26/72	-	-	-	-	-	-	Cow and calf trapped.
10/27/72	-	-	-	-	-	-	Cow seen with calf.
11/9/72	9:05-10:35 a.m.	1:30	-	-	-	-	Cow and calf walking fence.
11/14/72	10:30-10:55 a.m.	0:25	-	-	-	-	Cow watched me, calf not seen.
	2:40 p.m.	-	-	-	-	-	Cow and calf seen.
	3:15-3:45 p.m.	0:30	-	-	-	-	Cow seen with calf.
11/15/72	-	-	-	-	-	-	Cow seen with calf.
11/27/72	11:30 a.m.-1:00 p.m.	1:30	1:30	-	-	-	Cow seen, calf not seen.
	2:29-3:45 p.m.	1:16	0:28	0:13	0:35	-	Cow watched, calf only seen briefly.
12/14/72	-	-	-	-	-	0:45	Cow and calf seen after chase.
	11:20 a.m.-3:35 p.m.	4:15	0:31	0:00	2:40	-	Cow up and down five times, near calf early, searching for calf later.
	11:40 a.m.-noon	0:20	-	-	0:15	-	Calf was near mother.
	2:25 p.m.	-	-	-	-	-	Saw calf running. Not with mother.
12/21/72	8:52 a.m.	-	-	-	-	-	Saw cow, calf not seen, but calf tracks were present.
	12:40 p.m.	-	-	-	-	3:50	Cow seen as she ran away.
	12:50-3:15 p.m.	2:25	0:05	-	2:20	-	Cow watched, calf not seen.
1/2/73	-	-	-	-	-	-	Cow seen with calf.
1/22/73	-	-	-	-	-	-	Lone uncollared calf seen this date.
1/29/73	12:23-1:15 p.m.	0:52	0:52	-	-	-	Cow seen without calf.
2/2/73	-	-	-	-	-	-	Cow seen, calf not seen.
2/14/73	-	-	-	-	-	-	Cow seen, calf not seen.
2/16/73	12:25 p.m.	-	-	-	-	-	Cow seen, calf not seen.
	1:35 p.m.	-	-	-	-	-	Cow seen, calf not seen. Lone uncollared calf seen; no calves seen in Pen 1 after this date.
2/20/73	-	-	-	-	-	-	Cow seen without calf.
2/27/73	-	-	-	-	-	-	Cow seen without calf.
3/1/73	-	-	-	-	-	-	Cow seen, no calf seen.
4/5/73	-	-	-	-	-	-	Cow seen without calf.
4/6/73	-	-	-	-	-	-	Cow trapped, no calf seen.

Table 3. Observations of cow No. R70-7 and uncollared female calf in Pen 2.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
6/20/72	-	-	-	-	-	-	First sighting of calf (born in Pen 2).
6/29/72	-	-	-	-	-	-	Cow seen with calf.
7/7/72	-	-	-	-	-	-	Cow seen with calf.
7/10/72	-	-	-	-	-	-	Cow and calf in trap 2E.
7/19/72	-	-	-	-	-	-	Cow seen with calf.
8/11/72	-	-	-	-	-	-	Cow in trap 2S, calf not seen.
8/23/72	-	-	-	-	-	-	Cow seen with calf.
10/7/72	-	-	-	-	-	-	Cow seen near bull, calf not seen.
10/30/72	-	-	-	-	-	-	Cow seen with calf.
11/9/72	-	-	-	-	-	-	Cow seen with calf.
11/15/72	-	-	-	-	-	-	Cow seen with calf.
11/22/72	-	-	-	-	-	-	Cow with calf in SW Pen 2.
11/28/72	-	-	-	-	-	-	Cow with calf and bull behind cabin.
12/1/72	2:15-3:20 p.m.	1:05	0:45	-	0:20	-	Cow (w/calf) feeding on down aspen.
	2:15-3:20 p.m.	1:05	0:40	0:06	0:05	-	Calf (w/mother) feeding, watching me, twice put nose between mother's legs.
12/27/72	10:45 a.m.-noon	1:15	0:05	0:07	1:03	-	Cow (w/calf) feeding, they lay down.
	10:45 a.m.-noon	1:15	0:05	0:09	1:00	-	Calf lay down within 3 meters of cow.
	1:20 p.m.	-	-	-	-	-	Cow and calf standing where seen earlier.
1/5/73	8:40-8:55 a.m.	0:15	-	0:15	-	-	Cow (w/calf) near road in NE Pen 2.
	8:45-8:55 a.m.	0:10	-	0:07	-	-	Calf (w/mother).
	8:55 a.m.	-	-	-	-	-	Calf nursed from side (15 sec. or less).
	9:03-9:08 a.m.	0:05	-	0:05	-	-	Cow (w/calf) using nose to crater.
	9:03-9:08 a.m.	0:05	-	0:05	-	-	Calf (right beside cow) pawing in snow.
1/8/73	1:52-2:20 p.m.	0:28	-	-	0:23	-	Cow (w/calf) standing, then lay down.
	1:52-2:20 p.m.	0:28	-	-	?	-	Calf (w/mother) lay down, got up, was lying down again 5 meters from cow.
1/9/73	9:05-10:35 a.m.	1:30	1:30	-	-	-	Cow breaking over several birches.
	10:22-10:35 a.m.	0:13	0:13	-	-	-	Calf appeared in regrowth near mother.
	2:08-2:35 p.m.	0:27	-	0:24	0:03	-	Cow (w/calf) got up, pawed along log.
	2:08-2:35 p.m.	0:27	0:24	-	-	-	Calf moved to cow's side, cow got up.
1/10/73	9:32-10:15 a.m.	0:43	0:43	-	-	-	Cow (w/calf) eating birch.
	9:30-10:15 a.m.	0:45	0:40	0:05	-	-	Calf within 25 meters of cow.
1/23/73	-	-	-	-	-	-	Cow with calf browsing.

Table 3. (cont'd.) Observations of cow No. R70-7 and uncollared calf in Pen 2.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
1/24/73	8:50-10:02 a.m.	1:12	0:06	-	1:02	-	Calf near cow, then lost in regrowth.
	9:01 a.m.-4:20 p.m.	7:19	2:03	2:13	3:03	-	Cow (w/calf) feeding, lying down, feeding.
	11:12 a.m.	-	-	-	-	-	Calf seen again standing by mother.
	11:13 a.m.-1:33 p.m.	2:20	-	-	2:20	-	Calf lying with face against face of mother part of time.
	1:33-4:20 p.m.	2:47	1:05	1:42	-	-	Calf cratering, then browsing.
1/29/73	2:47-3:05 p.m.	0:18	-	-	0:18	-	Cow and calf lying 10 meters apart.
2/1/73	9:11-9:30 a.m.	0:19	-	-	0:19	-	Cow and calf 15 meters apart.
2/20/73	1:48-4:05 p.m.	2:17	1:15	0:37	0:15	-	Cow (w/calf), standing, feeding, lying down.
	1:48-4:05 p.m.	2:17	1:13	0:38	0:11	-	Calf (w/mother), standing, feeding, lying down.
∞ 2/21/73	1:16-2:45 p.m.	1:29	0:29	0:21	0:33	-	Cow (w/calf) browsing, cratering, lying down.
	1:20-2:45 p.m.	1:25	0:34	0:18	0:31	-	Calf (w/cow) browsing, cratering, lying down.
	3:40 p.m.	-	-	-	-	-	Cow got up as I approached, calf was already standing.
	4:40 p.m. *	-	-	-	-	-	Cow and calf browsing birch.
2/22/73	12:53-1:30 p.m.	0:37	0:37	-	-	-	Cow 60-70 meters from calf initially.
	12:53-1:30 p.m.	0:37	0:37	-	-	-	Calf near me, then went toward cow.
	1:50-5:15 p.m.	3:25	0:11	0:49	2:18	-	Cow (w/calf) in area of sparse regrowth.
	1:50-5:15 p.m.	3:25	0:17	1:07	1:54	-	Calf (w/mother). Beds 6-7 meters apart. Moose alternately browsing and cratering.
2/23/73	9:30 a.m.-1:20 p.m.	3:50	0:11	-	3:39	-	Cow (w/calf) lying down, then browsing.
	9:30 a.m.-1:20 p.m.	3:50	0:12	-	3:37	-	Calf moved from previous bed to cow, lay down. Later licked mother's collar and shoulder while both were lying.
2/26/73	4:16-5:05 p.m.	0:49	0:35+	0:05+	-	-	Cow (w/calf) near edge of timber.
	4:16-5:05 p.m.	0:49	0:35	?	-	-	Calf within 15 meters of cow whole time.
2/28/73	3:59-4:36 p.m.	0:37	0:13	0:24	-	-	Cow (w/calf). Both in same crater for 7 minutes.
	3:59-4:36 p.m.	0:37	0:08	0:27	-	-	Calf enlarging crater dug by cow, also eating <i>Vaccinium</i> uncovered by cow.

Table 3. (cont'd.) Observations of cow No. R70-7 and uncollared female calf in Pen 2.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
2/28/73	5:27-5:33 p.m.	0:06	0:06	-	-	-	Cow browsing 50 meters from calf.
	5:31-5:33 p.m.	0:02	0:02	-	-	-	Calf browsing 50 meters from mother.
3/3/73	11:33 a.m.-12:10 p.m.	0:37	-	-	0:37	-	Cow (w/calf) in area of sparse regrowth.
	11:33 a.m.-12:10 p.m.	0:37	-	-	0:37	-	Calf lying about 50 meters from cow.
3/5/73	3:33-3:40 p.m.	0:07	-	-	-	-	Calf standing, walking, then began to paw.
	4:20-5:25 p.m.	1:05	0:14	-	0:51	-	Cow lying down, later browsing.
	4:35-5:25 p.m.	0:50	0:41	0:05	-	-	Calf initially 135 meters from cow and down steep slope. Later browsed to within 50 meters of cow (4 meters from me).
3/6/73	2:58-3:50 p.m.	0:52	0:29	-	0:23	-	Cow lying 8 meters from calf, then browsing.
	2:58-5:05 p.m.	2:07	0:30	0:05	1:17	-	Calf lying near cow, then cratering, then alternately standing and browsing. Finally browsing within 50 meters of mother.
3/7/73	4:45-5:05 p.m.	0:20	0:20	-	-	-	Cow seen again 35-50 meters from calf.
	4:15-5:40 p.m.	1:25	0:08	0:59	0:16	-	Cow (w/calf). Both in same crater for 12 min.
	4:15-5:40 p.m.	1:25	0:05	0:28	0:20	-	Calf initially lay down 20 yds. from cow. Got up, cratered 3-4 meters from mother. Moved into mother's crater and fed without pawing (3 min.). Later fed in old crater w/o pawing (1 min.). Twice pawed w/o feeding (3 min.) Spent 25 min. just standing and occasionally nosing or eating snow.
3/8/73	2:22-2:47 p.m.	0:25	0:05	-	0:20	-	Cow (w/calf) lying, then browsed over ridge.
	2:22-3:25 p.m.	1:03	-	-	0:55	-	Calf lying 20 meters from cow. After cow moved away, calf remained lying down. Calf got up (slowly) only when I approached within 20 meters. Then just stood for 8 min.
3/11/73	4:39-5:35 p.m.	0:57	0:18	-	0:39	-	Cow watched, calf not with her.
	5:47 p.m.	-	-	-	-	-	Found calf dead about 125 meters south of mother. Cratering in fresh snow indicated that mother had been near calf after calf died.
3/12/73	-	-	-	-	-	-	Samples taken from dead calf (DC-4).
3/15/73	-	-	-	-	-	-	Cow seen south of seis. trail.
4/16/73	-	-	-	-	-	-	Cow seen south of Pen 2 road (NE).
4/26/73	-	-	-	-	-	-	Cow processed (using helicopter).
4/27/73	-	-	-	-	-	-	Cow seen in low area east of cabin.

to be very tolerant of her calf. However, it seemed that the calf, rather than the mother, maintained the closeness of the pair. The calf was seen nursing on January 5, 1973. On February 23, the calf got up as the observer approached. The calf then moved to her mother's side and lay down again. While both were lying down, the calf licked the mother's collar and shoulder. On February 28 and March 7, 1973, the calf fed on *Vaccinium* which the mother had uncovered. Both cow and calf were in the crater at the same time. However, the cow obviously was not purposely uncovering vegetation for the calf. She merely tolerated the calf's company as the calf fed in the crater.

Cow No. 79 and her calf (No. 82 female) were last seen together on February 1, 1973 (Table 4). They had been seen many times previously and were usually quite near each other. However, on January 8, 1973, the calf was browsing about 200 meters from her mother, who was lying in the timber up a steep slope and out of sight of the calf. On the last day they were seen together, the calf moved beside the mother and both pawed in the same crater (February 1, 1973). On February 15, 1973, the calf was located alone in the eastern portion of Pen 2. On February 18 and 19, the calf was still alone and appeared weak. On February 19, the mother was seen one-half kilometer to the west of the calf. The following day (February 20), the calf was found dead.

Cow No. 52 and her calf (No. 83) were often radio-tracked and seen together (Table 5). However, this cow was very wild and usually ran away roar-bellowing as she went. The calf was last seen with his mother on January 25, 1973. On February 5, 1973, the calf was alone. On February 15, both the cow and calf were seen, but they were one kilometer apart. The calf was not seen after this date and was assumed to have died.

Pen 4

No. 89 cow and her calf (No. 90) were radio-tracked several times in the regrowth area of western Pen 4 (Table 6). Both moose had radios and signals indicated that they were together even when they were not seen. They were often pursued for extended periods, but were usually seen only briefly. On January 26, 1973, the cow was seen in central Pen 4. Instead of running, she actually approached the observer and vocalized. Later, she appeared to be searching the area and again vocalized. Her calf was found dead nearby on this same date. The cow was still near her dead calf four days later on January 30, 1973.

Cow No. 87 and her calf (No. 88) were seen together on 14 different occasions before the calf was seen alone on January 4, 1973 (Table 7). This pair usually allowed the observer to approach quite closely, but the calf was somewhat bothered when the observer moved while the cow was lying down. On November 24, 1972, while the cow remained lying down, the calf twice got up and moved nearer to his mother. He was finally lying within five meters of the cow. On several other occasions the calf got up after apparently being disturbed by the observer's presence. After the calf was first seen alone (January 4, 1973), the cow and calf were often observed, but were never seen together. The cow was always

Table 4. Observations of cow No. 79 and female calf No. 82 in Pen 2.

Date	Observation Time	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
6/12/72	-	-	-	-	-	-	Calf first seen (born in pen).
6/26/72	-	-	-	-	-	-	Cow seen with calf.
6/27/72	-	-	-	-	-	-	Cow seen with calf.
6/28/72	-	-	-	-	-	-	Cow seen with calf.
7/1/72	-	-	-	-	-	-	Cow and calf watched.
7/2/72	-	-	-	-	-	-	Cow and calf vocalizations recorded.
7/9/72	-	-	-	-	-	-	Cow seen with calf.
7/10/72	-	-	-	-	-	-	Cow trapped and marked, calf not seen.
8/5/72	-	-	-	-	-	-	Cow seen with calf.
8/8/72	-	-	-	-	-	-	Cow seen, calf not seen.
8/10/72	-	-	-	-	-	-	Cow and calf trapped, calf marked.
8/23/72	-	-	-	-	-	-	Cow seen with calf.
9/20/72	-	-	-	-	-	-	Cow seen, calf not seen.
9/21/72	-	-	-	-	-	-	Cow seen with calf.
9/22/72	-	-	-	-	-	-	Cow seen with calf.
9/27/72	-	-	-	-	-	-	Calf seen, cow not seen.
11/10/72	-	-	-	-	-	-	Cow trapped, calf seen nearby.
11/15/72	-	-	-	-	-	-	Cow seen with calf.
12/12/72	10:03-10:08 a.m.	0:05	0:05	-	-	-	Calf watched near fenceline.
	10:08 a.m.	-	-	-	-	-	Mother appeared, cow and calf ran.
	10:28-10:40 a.m.	0:12	-	-	-	-	Cow and calf standing, then ran.
12/28/72	9:35-9:58 a.m.	0:33	0:23	-	-	-	Cow watched (calf with her).
	9:28-9:40 a.m.	0:12	0:05	-	-	-	Calf watched (mother with calf).
	10:15 a.m.	-	-	-	-	-	Cow seen with calf again.
1/3/73	-	-	-	-	-	-	Cow seen with calf.
1/8/73	11:30-11:41 a.m.	0:11	-	-	-	-	Cow watching me, calf not seen.
	11:41 a.m.-1:35 p.m.	-	-	-	1:54	-	Cow seen lying in same place.
	12:05-13:30 p.m.	0:25	0:25	-	-	-	Calf watched, 200 meters from mother but much closer to No. 1 female and No. 36 male.
	1:05 p.m.	-	-	-	-	-	Calf seen still feeding.
	1:28 p.m.	-	-	-	-	-	Calf lying down 165 meters from cow.
1/9/72	1:17-1:25 p.m.	0:08	-	-	-	-	Cow standing, calf seen briefly.
	1:45 p.m.	-	-	-	-	-	Cow seen with calf again.

Table 4. (cont'd.) Observations of cow No. 79 and female calf No. 82 in Pen 2.

Date	Observation Time	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
1/9/73	8:35-9:40 a.m.	1:05	0:20	0:23	0:22	-	Cow watched (with calf).
	8:50-9:40 a.m.	0:50	0:05	0:15	0:30	-	Calf watched (with mother).
1/29/73	4:33-4:48 p.m.	0:15	0:05	-	0:05	-	Cow got up, browsed, moved to calf.
	4:40-4:48 p.m.	0:08	0:08	-	-	-	Calf got up, browsed toward mother.
1/31/73	-	-	-	-	-	-	Cow seen with calf.
2/1/73	4:20-4:55 p.m.	0:35	-	0:25	0:10	-	Cow got up, cratered (with calf).
	4:32-4:55 p.m.	0:23	-	0:17	0:06	-	Calf got up, cratered (with mother).
2/15/73	1:00-2:15 p.m.	1:15	0:23	-	0:52	-	Calf alone on this date.
2/18/73	3:30-4:10 p.m.	0:40	0:00	0:00	0:00	0:00	Calf alone, appeared weak.
2/19/73	2:10&2:25 p.m.	-	-	-	-	-	Cow alone in southwest Pen 2.
	4:30-5:10 p.m.	0:40	-	-	0:40	-	Calf alone in SE Pen 2, could not rise.
2/20/73	-	-	-	-	-	-	Cow seen alone in SW Pen 2. Calf found dead in SE Pen 2.
2/21/73	-	-	-	-	-	-	Samples taken from dead calf.
3/4/73	-	-	-	-	-	-	Cow seen near trap 2S.
3/5/73	-	-	-	-	-	-	Cow seen near trap 2S.
3/8/73	-	-	-	-	-	-	Cow seen near trap 2S.
4/5/73	-	-	-	-	-	-	Cow seen 1/4 kilometer south of cabin.

Table 5. Observations of cow No. 52 and male calf No. 83 in Pen 2.

Date	Observation Time	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
6/20/72	-	-	-	-	-	-	First sighting of calf.
6/26/72	-	-	-	-	-	-	Cow seen, calf not seen.
6/29/72	-	-	-	-	-	-	Cow trapped, calf nearby.
7/11/72	-	-	-	-	-	-	Cow seen, calf not seen.
7/12/72	-	-	-	-	-	-	Cow trapped, calf not seen.
8/3/72	-	-	-	-	-	-	Cow trapped, calf not seen.
8/25/72	-	-	-	-	-	-	Cow seen with calf.
9/6/72	-	-	-	-	-	-	Calf trapped, cow nearby.
9/16/72	-	-	-	-	-	-	Cow seen, calf not seen.
9/18/72	-	-	-	-	-	-	Cow seen, calf not seen.
11/13/72	3:45 p.m.	-	-	-	-	2:25	Cow seen with calf.
11/15/72	-	-	-	-	-	-	Cow seen with calf.
11/26/72	12:45-3:45 p.m.	-	-	-	-	2:30	Cow seen with calf.
12/2/72	2:45 p.m.	-	-	-	-	0:45	Cow seen with calf.
12/12/72	1:38&2:55 p.m.	-	-	-	-	1:17+	Cow seen with calf.
12/22/72	9:30 a.m.	-	-	-	-	-	Cow seen with calf.
1/9/73	12:55 p.m.	-	-	-	-	1:55	Cow seen with calf.
1/25/73	9:00&10:14 a.m.	-	-	-	-	1:09	Cow seen with calf.
2/5/73	-	-	-	-	-	-	Calf seen without mother.
2/7/73	-	-	-	-	-	-	Calf seen without mother.
2/13/73	-	-	-	-	-	-	Calf seen without mother.
2/15/73	11:20 a.m.	-	-	-	-	-	Cow seen in SE Pen 2.
	3:28 p.m.	-	-	-	-	-	Calf seen in NW Pen 2.
2/20/73	-	-	-	-	-	-	Cow seen without calf.
2/21/73	3:01 p.m.	-	-	-	-	-	Cow seen without calf.
3/23/73	2:05 p.m.	-	-	-	-	-	Cow seen without calf.
4/5/73	-	-	-	-	-	-	Cow seen without calf.

Table 6. Observations of cow No. 89 and female calf No. 90 in Pen 4.

Date	Observation Time	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
11/2/72	-	-	-	-	-	-	Cow and calf put into pen.
11/10/72	-	-	-	-	-	2:00	Cow glimpsed twice, calf not seen but probably with cow.
11/22/72	1:35 p.m.	-	-	-	-	5:00	Cow seen with calf.
11/29/72	-	-	-	-	-	-	Cow seen, calf not seen.
12/7/72	-	-	-	-	-	-	Cow seen, calf not seen, but probably with mother.
12/19/72	1:08&1:12 p.m.	-	-	-	-	-	Cow and calf seen at fence.
1/3/73	2:11 p.m.	-	-	-	-	1:30	Cow seen with calf.
1/24/73	-	-	-	-	-	-	Cow seen, calf not seen.
1/26/73	12:35-12:45 p.m.	0:10	-	-	-	-	Cow searching for calf.
	2:45 p.m.	-	-	-	-	-	Found dead calf.
	3:24 p.m.	-	-	-	-	-	Cow seen near dead calf.
1/30/73	11:27 a.m.&1:15 p.m.	-	-	-	-	-	Cow seen near dead calf.
2/8/73	-	-	-	-	-	-	Cow seen at west fence.

Table 7. Observations of cow No. 87 and male calf No. 88 in Pen 4.

Date	Observation Time	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
10/26/72	-	-	-	-	-	-	Cow and calf trapped, put into pen.
11/2/72	-	-	-	-	-	-	Cow seen with calf at fence.
11/10/72	2:20-3:00 p.m.	0:40	0:05	-	-	-	Cow (with calf) standing watching me.
	2:20-3:00 p.m.	0:40	-	-	-	-	Calf (with mother) standing.
11/11/72	-	-	-	-	-	-	Cow seen with calf.
11/20/72	-	-	-	-	-	-	Cow seen with calf.
11/21/72	10:40 a.m.	-	-	-	-	-	Cow seen in western Pen 4; calf not seen but radio signal heard.
	2:55-4:00 p.m.	1:05	-	0:55	-	-	Cow (with calf) in NE Pen 4.
	3:10-4:00 p.m.	0:50	-	0:40	-	-	Calf (with mother) in NE Pen 4.
11/24/72	11:20 a.m.-12:15 p.m.	0:55	-	-	0:55	-	Cow (with calf) in central Pen 4.
	11:25 a.m.-12:15 p.m.	0:50	-	-	0:40	-	Calf up and down twice, each time moving nearer to mother.
11/29/72	-	-	-	-	-	-	Cow and calf at north fence.
12/4/72	9:35-11:45 a.m.	2:10	-	-	-	-	Cow (with calf) walking SE fenceline.
	9:35-11:45 a.m.	2:10	-	-	?	-	Calf (with cow) walking and lying down.
	12:50-3:15 p.m.	2:25	-	0:48	1:37	-	Cow (with calf) in timber.
	12:50-3:15 p.m.	2:25	0:05	1:05	1:10	-	Calf (with mother) down and up twice.
	3:45 p.m.	-	-	-	-	-	Cow and calf feeding in timber.
12/9/72	11:52-11:58 a.m.	0:06	-	-	0:06	-	Cow (with calf) lying in timber.
	11:52-11:58 a.m.	0:06	-	-	-	-	Calf (with mother) up, then down again.
12/17/72	10:47 a.m.-3:03 p.m.	4:16	0:19+	1:12+	2:17	-	Cow (with calf); several moose nearby.
	10:47 a.m.-3:03 p.m.	4:16	0:24+	1:11+	2:13	-	Calf (with mother) feeding and lying.
	3:03 p.m.	-	-	-	-	-	Calf got up as I moved away.
	3:20-3:30 p.m.	0:10	-	-	0:10	-	Cow (with calf) as I returned to area.
	3:20-3:30 p.m.	0:10	-	-	0:05	-	Calf got up, then lay down again.
12/19/72	-	-	-	-	-	-	Cow with calf in SE corner of pen.
12/20/72	9:48 a.m.	-	-	-	-	-	Cow and calf with calf No. 95.
	9:48 a.m.-1:00 p.m.	3:12	-	-	3:08	-	Cow (with calf after No. 95 ran away).
	9:48 a.m.-1:00 p.m.	3:12	-	-	3:05	-	Calf (lying within 5 meters of cow).
12/30/72	2:05 p.m.	-	-	-	-	-	Calf seen; stood, then ran.
	2:10 p.m.	-	-	-	-	-	Cow seen as calf ran to her.
	2:55 p.m.	-	-	-	-	-	Cow and calf feeding 100 meters apart.

Table 7. (cont'd.) Observations of cow No. 87 and male calf No. 88 in Pen 4.

Date	Observation Time	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
1/4/73	3:22-3:30 p.m.	0:08	-	-	0:08	-	Calf alone; got up and ran away.
1/5/73	11:38-11:53 a.m.	0:15	0:03	-	-	-	Calf alone; got up, slowly moved away.
1/15/73	Between 1:38 p.m. and 4:08 p.m.	-	-	-	-	-	Cow seen several times at or near fenceline in NW Pen 4. Calf not seen.
1/16/73	1:08 p.m.	-	-	-	-	-	Calf seen alone in eastern Pen 4.
	1:20-1:45 p.m.	0:25	0:05	0:20	-	-	Calf alone, feeding and moving.
	4:13 p.m.	-	-	-	-	-	Cow seen over 1-1/2 kilometers west of calf.
1/17/73	1:52-2:15 p.m.	0:23	-	-	0:18	-	Cow at west fence, calf not seen.
1/18/73	-	-	-	-	-	-	Cow caught in trap 4 NW.
	9:35-10:25 p.m.	0:50	0:40	-	0:10	-	Calf alone in eastern Pen 4.
1/20/73	1:43&2:50 p.m.	-	-	-	-	-	Cow in NW Pen 4, calf not seen.
1/23/73	-	-	-	-	-	-	Cow along west fence, calf not seen.
1/24/73	-	-	-	-	-	-	Cow along west fence, calf not seen.
1/25/73	11:37 a.m.-12:17 p.m.	0:40	0:40	-	-	-	Calf alone in eastern Pen 4.
	12:26-12:50 p.m.	0:24	-	0:11	0:13	-	Calf lying down as I left area. Calf seen at west fence.
1/26/73	4:25&4:35 p.m.	-	-	-	-	-	Cow at west fence, calf not seen.
1/30/73	2:08 p.m.	-	-	-	-	-	Calf alone, walking away fast.
	3:33-2:50 p.m.	0:17	-	0:17	-	-	Calf alone in eastern Pen 4.
1/31/73	10:47&11:13 a.m. and 2:18 p.m.	-	-	-	-	-	Cow in NW Pen 4, calf not seen.
2/1/73	1:12 p.m.	-	-	-	-	-	Cow in NW corner, calf not seen.
2/2/73	-	-	-	-	-	-	Cow at NW corner with two moose.
	9:13-9:18 a.m.	0:05	-	0:05	-	-	Calf alone in eastern Pen 4.
2/5/73	-	-	-	-	-	-	Cow caught in trap 4 NW.
2/9/73	-	-	-	-	-	-	Cow caught in trap 4 NW.
2/19/73	-	-	-	-	-	-	Cow seen at west fence. Calf found dead more than 1/2 kilometer east of mother, but more than 1 kilometer west of place last seen alive (2 Feb. 73).
2/14/73	-	-	-	-	-	-	Cow seen at west fence. Samples taken from dead calf.
2/15/73	-	-	-	-	-	-	Cow in NW corner with two moose.
2/16/73	-	-	-	-	-	-	Cow caught in trap 4 NW.
2/20/73	-	-	-	-	-	-	Cow seen at north fence.
3/19/73	-	-	-	-	-	-	Cow found dead about 50 meters south of trap 4 NW.
3/29/73	-	-	-	-	-	-	Samples taken from dead cow.

seen in northwestern Pen 4 and the calf was usually about one and one-half kilometers to the east. The calf lived for about a month (probably slightly longer) after being separated from the cow.

Cow No. 91 and calf No. 92 were seen apart more often than they were seen together (Table 8). They were first seen apart on November 20, 1972, when the cow was seen two kilometers east of the calf. Though often seen apart after this date, they were both always seen in western Pen 4 on subsequent sightings. This cow seemed more wary when she was with her calf. She was seen many times walking the fenceline in northwestern Pen 4. On December 18, 1972, the calf was observed for several hours. The cow walked through the area, but did not join her calf. Two days later, the pair were seen together for the last time (December 20, 1972). However, it is possible that they were together at later dates. On January 15, 1973, the calf was seen in northwestern Pen 4. The calf heard a moose approaching, then vocalized and trotted toward the sound. The calf probably expected to see her mother, but instead found No. 87 female, at the fenceline. On January 17, 1973, an unidentified moose was seen near the mother. It moved away quickly and the calf was later seen 300 meters south of the mother. The unidentified moose may have been the calf. The calf was found dead on January 31, 1973.

Cow No. 85 and her calf (No. 86) usually ran from the observer with the cow roar-bellowing (Table 9). The calf was first seen alone on January 18, 1973. After being seen alone, the calf circled around the observer and moved to the northwest. About two and one-half hours later, the calf was seen with his mother about 300 meters to the northwest of the earlier sighting. On the following day (January 19, 1973), the calf was seen as he disappeared in the regrowth about 60-70 meters southeast of his mother, who was lying down. This was the last time the calf was seen alive. On January 25, 1973, the cow was seen in northwest Pen 4 and fresh calf tracks and droppings were seen in the area. However, another calf may have been in the area. Calf No. 86 was found dead on March 4, 1973.

The unmarked calf of cow No. 123 was not regularly seen and was last observed on October 20, 1972 (Table 10). The calf was extremely wary and may have been alive some time after the last observation since it was not regularly seen with the cow prior to this.

Factors Possibly Influencing Separation and Mortality

The introduction of cows and calves from outside the pens into Pen 4 may have been an important influence in the separations which took place in this pen. Cow No. 91 and cow No. 87 were often seen along the fencelines in northwestern Pen 4. In the case of No. 91, she was often seen at the fenceline before she was last seen with her calf. However, No. 87 was not seen at the west fenceline until after she had become separated from her calf.

Being radio- or snow-tracked by an observer may also have been a factor in some of the separations. However, since the responses of the various cow/calf pairs were very different, this factor is difficult to

Table 8. Observations of cow No. 91 and female calf No. 92 in Pen 4.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
11/11/72	-	-	-	-	-	-	Cow and calf trapped, put into pen.
11/13/72	11:50 a.m.-12:05 p.m.	0:15	-	-	-	-	Cow with calf standing in timber.
	1:05-1:10 p.m.	0:05	-	-	-	-	Cow with calf trotting along fence.
11/20/72	2:02 p.m.	-	-	-	-	-	Calf seen alone in NW Pen 4.
	About 3:30 p.m.	-	-	-	-	-	Cow seen along fence in SE Pen 4.
11/21/72	-	-	-	-	-	-	Cow along north fence without calf.
11/22/72	1:20&1:37 p.m.	-	-	-	-	-	Calf seen alone, then ran away.
	2:20-3:40 p.m.	1:20	1:20	-	-	-	Cow with calf and No. 36 female.
11/27/72	-	-	-	-	-	-	Calf seen along fence, mother not seen.
11/28/72	9:25-9:53 a.m.	0:28	-	-	-	-	Cow along fence, then lay down.
	10:37-11:15 a.m.	0:38	-	-	0:38	-	Calf 1/4 kilometer south of mother.
	12:03 p.m.	-	-	-	-	-	Mother seen at same place as at 9:53.
11/29/72	-	-	-	-	-	-	Cow with calf in NW corner of pen.
11/30/72	-	-	-	-	-	-	Cow with calf along west fence.
12/1/82	-	-	-	-	-	-	Cow seen with No. 84 female. Calf not seen.
12/5/72	-	-	-	-	-	-	Cow with calf along west fence.
12/7/72	1:05-1:16 p.m.	0:11	-	0:05	-	-	Cow (with calf)) Watching me and
	1:00-1:16 p.m.	0:16	-	0:05	-	-	Calf (with mother)) feeding, then
							) moved away.
	3:15-3:17 p.m.	0:02	-	-	-	-	Cow with calf near six other moose.
12/8/72	11:13 a.m.-12:10 p.m.	0:57	-	-	-	-	Calf just standing (not with mother).
	1:25 p.m.	-	-	-	-	-	Calf seen again, ran away.
	2:04-3:15 p.m.	1:11	0:26	-	0:43	-	Cow watched, calf not with her.
12/18/72	11:10 a.m.-3:55 p.m.	4:45	-	0:08	3:40	-	Calf watched, mother seen briefly.
							(Calf standing or walking for 57 min.)
	12:50&1:10 p.m.	-	-	-	-	-	Cow seen walking through area.
12/19/72	9:00 a.m.&3:45 p.m.	-	-	-	-	-	Cow seen at west fenceline.
	9:35 & 10:20 a.m.	-	-	-	-	-	Calf seen over 1/4 kilometer east of mother.
12/20/72	3:38-4:10 p.m.	0:32	-	-	-	-	Cow with calf walking west fence.

Table 8. (cont'd.) Observations of cow No. 91 and female calf No. 92 in Pen 4.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
12/21/72	-	-	-	-	-	-	Cow seen at west fence, calf not seen.
1/3/73	10:50 a.m.	-	-	-	-	-	Calf seen; tracks and beds in new snow indicated that cow had been with calf earlier in morning.
	2:40&2:45 p.m.	-	-	-	-	-	Calf seen near earlier location.
	Approx. 3:30 p.m.	-	-	-	-	-	Cow seen 300 meters NW of calf.
1/5/73	-	-	-	-	-	-	Cow seen at north fence, calf not seen.
1/15/73	2:03&2:10 p.m.	-	-	-	-	-	Calf seen, mother not seen.
	2:42-3:12 p.m.	0:30	-	-	0:30	-	Calf watched; mother not seen.
	3:17-3:45 p.m.	-	-	-	-	-	Calf with No. 87 female at fence after vocalizing and trotting toward sound.
1/16/73	3:22&4:00 p.m.	-	-	-	-	-	Calf seen, mother not seen.
1/17/73	9:50 a.m.-12:10 p.m.	2:20	0:05	0:10	2:04	-	Cow watched; unidentified moose (possibly calf) seen nearby earlier.
	1:11-1:39 p.m.	0:28	0:26	-	-	-	Calf watched (300 meters south of mother).
	2:25 p.m.	-	-	-	-	-	Mother seen again, calf not seen.
1/18/73	-	-	-	-	-	-	Cow trapped, calf not seen.
1/20/73	1:55-2:40 p.m.	0:45	0:45	-	-	-	Calf watched; she was alone.
	3:00-3:05 p.m.	0:05	-	-	-	-	Cow at fence approx. 3/4 kilometer west of calf.
1/22/73	-	-	-	-	-	-	Cow at fence, calf not seen.
1/23/73	-	-	-	-	-	-	Cow at fence, calf not seen.
1/24/73	-	-	-	-	-	-	Cow at fence, calf not seen.
1/26/73	11:25&11:45 a.m. and 4:35 p.m.	-	-	-	-	-	Cow seen, calf not seen.
1/31/73	-	-	-	-	-	-	Calf found dead.
2/1/73	-	-	-	-	-	-	Collected calf samples, cow at west fence.
2/2-3/12/73	-	-	-	-	-	-	Cow seen 12 times in NW Pen 4.

Table 9. *Observations of cow No. 85 and male calf No. 86 in Pen 4.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
9/18/72	-	-	-	-	-	-	Cow and calf put into pen.
10/7/72	-	-	-	-	-	-	Calf seen, mother not seen.
11/10/72	1:00 p.m.	-	-	-	-	0:30	Cow seen, calf not seen.
11/16/72	10:00 a.m.	-	-	-	-	1:00	Cow and calf seen running.
	12:22 p.m.	-	-	-	-	2:32	Cow seen with calf.
	2:44 p.m.	-	-	-	-	2:22	Cow seen with calf.
11/21/72	-	-	-	-	-	-	Cow seen, calf not seen.
11/28/72	1:12-1:21 p.m.	0:09	-	-	-	-	Cow stood, then walked away.
	1:21 p.m.	-	-	-	-	-	Calf appeared following cow.
12/5/72	2:15 p.m.	-	-	-	-	-	Cow and calf ran away.
12/8/72	9:33 a.m.	-	-	-	-	-	Cow and calf ran away.
12/19/72	3:42 p.m.	-	-	-	-	1:22	Cow and calf at fenceline.
12/20/72	2:40&2:42 p.m.	-	-	-	-	-	Cow and calf seen running.
1/3/73	3:30&4:10 p.m.	-	-	-	-	0:40	Cow seen with calf.
1/4/73	9:40 a.m.	-	-	-	-	-	Cow and calf along fence.
1/12/73	9:45 a.m.	-	-	-	-	-	Cow seen with calf.
1/15/73	12:47 p.m.	-	-	-	-	-	Cow and calf seen at fence.
	1:00-1:38 p.m.	0:38	-	-	0:15	-	Cow watching me or lying down.
	1:18-1:38 p.m.	0:20	-	-	0:10	-	Calf near mother (along fence).
	1:38 p.m.	-	-	-	-	-	Cow and calf trotted away.
1/18/73	11:52 a.m.-12:15 p.m.	0:23	-	-	-	-	Calf (alone) moving away from me.
	2:55-3:18 p.m.	0:23	-	0:20	-	-	Cow watched (calf with her).
	2:55-3:18 p.m.	0:23	-	0:13	-	-	Calf watched (with cow).
	3:18 p.m.	-	-	-	-	-	Cow walked away followed by calf.

Table 9. (cont'd.) Observations of cow No. 85 and male calf No. 86 in Pen 4.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
1/19/73	2:37-2:40 p.m.	0:03	-	-	-	-	Watched cow until she lay down.
	3:18 p.m.	-	-	-	-	-	Saw calf disappear 70 meters from cow.
	2:40-3:30 p.m.	-	-	-	0:50	-	Cow remained lying down.
1/20/73	1:40 p.m.	-	-	-	-	-	Cow seen, calf not seen.
1/23/73	-	-	-	-	-	-	Cow trapped, calf not seen.
1/25/73	4:05-4:17 p.m.	0:12	-	0:12	-	-	Cow seen, calf not seen.
1/31/73	1:03 p.m.	-	-	-	-	-	Cow seen without calf.
	1:27-1:43 p.m.	0:16	-	-	-	-	Cow along fence without calf.
2/1/73	9:55-10:10 a.m.	0:15	-	-	0:15	-	Cow seen without calf.
2/4/73	-	-	-	-	-	-	Cow seen without calf.
2/6/73	-	-	-	-	-	-	Cow seen without calf.
2/7/73	-	-	-	-	-	-	Cow trapped, calf not seen.
2/13/73	-	-	-	-	-	-	Cow seen without calf.
2/16/73	-	-	-	-	-	-	Cow seen without calf.
2/20/73	-	-	-	-	-	-	Cow seen without calf.
3/4/73	-	-	-	-	-	-	Cow not seen, calf found dead (probably dead long time).
3/12/73	-	-	-	-	-	-	Cow seen near trap 4S.
3/13/73	-	-	-	-	-	-	Cow seen east of trap 4S.
3/30/73	-	-	-	-	-	-	Cow seen in eastern Pen 4.
4/5/73	-	-	-	-	-	-	Cow seen in eastern Pen 4.

Table 10. Observations of cow No. 123 and uncollared calf in Pen 4.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
6/9/72	-	-	-	-	-	-	Cow seen, calf not yet born.
6/14/72	-	-	-	-	-	-	Cow seen with new calf.
6/15/72	-	-	-	-	-	-	Cow and calf pursued by observer.
6/16/72	-	-	-	-	-	-	Cow and calf pursued by observer.
7/9/72	-	-	-	-	-	-	Cow seen with calf.
7/11/72	-	-	-	-	-	-	Cow trapped, calf not seen.
7/12/72	-	-	-	-	-	-	Cow trapped, calf not seen.
7/16/72	-	-	-	-	-	-	Cow seen with calf.
7/21/72	-	-	-	-	-	-	Cow trapped, calf not seen.
8/3/72	-	-	-	-	-	-	Cow trapped, calf nearby.
8/15/72	-	-	-	-	-	-	Cow and calf ran from bear.
9/6/72	-	-	-	-	-	-	Cow seen, calf not seen.
9/8/72	-	-	-	-	-	-	Cow trapped, calf not seen.
9/18/72	-	-	-	-	-	-	Cow seen, calf not seen.
9/26/72	-	-	-	-	-	-	Cow seen, calf not seen.
10/3/72	-	-	-	-	-	-	Cow trapped, calf not seen.
10/18/72	-	-	-	-	-	-	Cow seen with calf (Brenham).
10/20/72	-	-	-	-	-	-	Cow seen, calf nearby.
12/4/72	-	-	-	-	-	-	Cow seen without calf.
12/9/72	-	-	-	-	-	-	Cow seen without calf.
12/21/72	-	-	-	-	-	-	Cow trapped, calf not seen.
12/28/72	2:35-3:32 p.m.	0:57	0:57	-	-	-	Cow seen without calf.
1/5/73	9:48 a.m.	-	-	-	-	-	Cow seen without calf.
	10:25 a.m.	-	-	-	-	-	Cow seen without calf.
1/16/73	2:25-2:48 p.m.	0:23	0:23	-	-	-	Cow seen without calf.
2/1/73	3:13-3:25 p.m.	0:12	0:12	-	-	-	Cow seen without calf.

evaluate. No. 89 and her calf (No. 90) usually ran away when tracked, yet no separation took place. No. 52 and her calf (No. 83) also always ran from the observer and they did separate. R70-7 and her calf seemed unbothered by the observer's presence and they did not separate. Another pair in Pen 4 (No. 87 and calf No. 88) became separated, but seldom seemed very disturbed by the observer. It seems that separation due to this cause would be most likely when the cow and calf reacted differently to the observer. This might have happened in Pen 1 where cow No. 76 often allowed prolonged observation, but her calf was quite wary and sometimes remained hidden and at least once moved 150-200 meters away from the cow.

The weakening of calves due to malnutrition probably is an important factor in many cases of separation. Calves tend to become more localized and move around less as they become weaker. No. 82 calf moved very little between February 15 and February 20, 1973. She was found dead on February 20. Although R70-7 and her calf did not separate, their movements became quite limited during the final week of the calf's life. None of the sightings between March 4 and March 11, 1973, were more than 200 meters apart. The cow and calf were seen on six of these eight days. An outside calf remained very near the Moose Research Center headquarters for two weeks prior to his death on February 26 or 27, 1973. A cow believed to be his mother was sometimes very near the calf and was still in the area when the calf died. However, some cows may leave weakened calves behind and move to new feeding areas as was noted in Pen 3 when a calf was known to be alone for at least one week before it died on February 16, 1972. The cow was not in the vicinity of the calf during this week.

Snow condition (depth and hardness) may be another factor contributing to separation of cows and calves. During the severe winter of 1971-72 aerial surveys of moose in Game Management Unit 15 showed an increasing proportion of lone calves. In the winter of 1972-73, snow depth almost doubled from 18 cm to 36 cm at the end of December at the moose pens. Another storm at the end of January resulted in a snow depth of about 50 cm. However, one separation in Pen 1 and two or three separations in Pen 4 took place before the end of January. It does not seem that a healthy calf would become too weak to follow the mother after only one month of snow at a depth of 38 cm. Perhaps some of these calves were in poor condition when they were born or when going into their first winter.

Table 11 summarizes types of separation experienced in Pens 1, 2 and 4.

Orphan Calves (Behavior and Survival - Comparative Analysis)

Since the number of observations of orphan calves during the 1972-73 winter was very limited, it is difficult to compare orphan behavior with that of calves having mothers. The three orphans that were seen more than once always ran away when attempts were made to observe them closely. Tables 12, 13, 14 and 15 summarize orphan calf observations.

Survival rates of orphans cannot be compared with those of calves

Table 11. Types of separation of moose calves and mothers.

Pen Number	1	2	4
Number of cow/calf pairs	2	3	4 (from outside)
Number of permanent separations	1 or 2 (?)	2	1-3
Number of intermittent separations	-	0	0-2
Number of pairs never separated	0 or 1 (?)	1	1

Table 12. Observations of female orphan calf (94) - Pen 4.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Appropriate Time Pursued	Remarks
12/6/72	-	-	-	-	-	-	Calf and mother trapped. Calf put into pen.
12/9/72	12:40-12:47 p.m.	0:07	-	-	-	-	Lying down, then got up and ran.
	12:55 p.m.	-	-	-	-	-	Calf running along fence (NE corner).
12/17/72	10:55 a.m.	-	-	-	-	-	Calf seen with No. 59 male in timber.
	11:15 a.m.	-	-	-	-	-	Calf very close to 57 female and No. 59 male was also nearby.
	12:55-1:15 p.m.	0:20	-	-	-	-	Calf stood watching me, then moved away through timber.
12/19/72	-	-	-	-	-	-	Calf running along fence (NE corner).
12/20/72	11:00 a.m.	-	-	-	-	-	Calf seen at NE corner of pen.
	Noon	-	-	-	-	-	Calf at north fence at junction of Pens 2, 3 and 4.
1/12/73	Between 9:00 and 9:30 a.m.	-	-	-	-	-	Calf seen north of trap 4S. Ran.
1/26/73	1:00-1:30 p.m.	0:03	-	-	-	-	Calf lying in timber in central Pen 4S. Calf saw me, got up, ran south into regrowth area.
5/9/73	-	-	-	-	-	-	Calf found dead in southern Pen 4.

Table 13. Observations of female orphan calf (95) - Pen 4.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Appropriate Time Pursued	Remarks
12/6/72	-	-	-	-	-	-	Calf and mother trapped. Calf put in pen.
12/7/72	-	-	-	-	-	-	Radio-tracked, found bed and running tracks. Did not see calf.
12/8/72	-	-	-	-	-	-	Calf seen at south fence after I had radio-tracked in central Pen 4.
12/19/72	-	-	-	-	-	-	Calf seen NE of tent rock.
12/20/72	9:45-9:45 a.m.	0:03	-	-	-	-	Calf seen with No. 87 female, No. 88 calf. She ran.
	10:12-10:42 a.m.	0:30	-	-	0:30	-	Calf lying north of seis. trail (middle).
	10:42 a.m. *	-	-	-	-	-	Calf got up, stood, walked, then ran.
	3:20 p.m.	-	-	-	-	-	Radio signal indicated calf was south of north enclosure in western Pen 4.
1/4/73	12:55-12:58 p.m.	0:03	-	-	-	-	Calf in NE Pen 4. Soon ran away.
	2:35 p.m.	-	-	-	-	-	Calf seen again. South of trap 3S.
1/15/73	9:42-10:02 a.m.	0:02	-	-	0:02	-	Calf lying SW of north lake. Then she got up slowly, took a few slow steps, then trotted away to west.
1/31/73	-	-	-	-	-	-	Calf found dead near edge of timber in regrowth area NE of trap 4S. Thought calf had been dead less than one day.

Table 14. Observations of male orphan calf (96) - Pen 1.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
12/22/72	-	-	-	-	-	-	Calf trapped (no cow seen), put in pen.
12/27/72	-	-	-	-	-	-	Calf seen in NE corner of pen.
1/11/73	2:25 p.m.	-	-	-	-	3:30	Calf with No. 65 male in runway of trap 1E after long chase.
	2:45 p.m.	-	-	-	-	-	Calf again in trap runway with No. 65 male after going to SE corner of pen, turning west, and then coming back. Calf followed as bull walked north. Then calf moved away into timber.
1/23/73	-	-	-	-	-	-	Calf found dead. At SW corner of small lake west of north end of Bratlie Lake. Calf estimated dead 4-5 days.

Table 15. Observations of male orphan calf (97) - Pen 2.

Date	Observation Times	Total Time Watched	Time Browsing	Time Cratering	Time Lying Down	Approximate Time Pursued	Remarks
1/24/73	-	-	-	-	-	-	Calf trapped (no cow seen), put in pen.
2/1/73	-	-	-	-	-	-	Calf found dead in SW Pen 2. Snow on body indicated that calf died between 27 and 30 January.

having mothers because calf mortality in the moose pens was 100 percent. None of the four orphan calves was seen alive after January 26, 1973. Three of the orphans had been found dead by February 1, 1973. Three calves with mothers were known to be alive on or after February 15, 1973, in Pen 2. In Pen 1, a lone calf was seen on February 16, 1973. This calf had been separated from its mother, either cow No. 10 or cow No. 76. It might appear that calves having mothers survived longer than orphans if the four cow/calf pairs in Pen 4 were ignored. Two of the calves with mothers in Pen 4 were found dead before the end of January, 1973, and only one of the calves with a mother was known to have been alive as late as February 2, 1973. If the differences in time of death were significant, factors such as introduction of outside moose into the pens and the resulting behavioral disturbance and stress to the individual upon being enclosed must be considered. Pen 4 has been intentionally maintained with high densities of moose and the long-term effect of this upon the vegetation must also be a factor to be considered. Studies are currently in progress relative to browse productivity and utilization in all the enclosures at the Moose Research Center.

Three of the orphan calves were seen with other moose. On December 17, 1972, calf No. 94 was feeding in the timber very near to No. 59 (male) and later was seen near No. 57 (female). The calf remained near these two moose for more than two hours. Then she moved away when approached by the observer. On December 20, 1972, calf No. 95 was seen with No. 87 (female) and her calf, No. 88. Calf No. 95 moved away from the cow and calf when approached by the observer, even though the cow and calf were not alarmed. Calf No. 96 was radio-tracked and pursued for three and one-half to four hours in eastern Pen 1 on January 11, 1973. Then the calf was seen with bull No. 65. In this case, it seemed that the calf was seeking protection. After leaving the bull and being approached by the observer, the calf returned to the bull and stood very near to him. The calf followed the bull closely when the bull walked away. However, the calf moved away when the bull turned and walked back toward the observer.

Aerial survival counts in the area immediately outside the pens, which is in Game Management Subunit 15A, were conducted on February 26 and 27, 1973 to compare with the 100 percent pen mortality. The results of these two counts and those reported by Paul LeRoux and James Davis, Alaska Department of Fish and Game, Soldotna, for Units 7 and 15 are listed in Table 16.

Survival percentages were lower in the area immediately around the pens (5.4 and 5.2 percent) than in the remainder of Subunit 15A (7.9, 6.5 and 10.1 percent). Subunits 15B and 15C had higher survival percentages (16.1 to 16.3 percent) than Subunit 15A, while the Unit 7 survival count (7.1 percent) was similar to those reported for Subunit 15A. Many factors may influence these disparities, including small sample size and distribution bias, but to relate to the poor survival within the enclosures and in the area immediately surrounding the pens, several other factors should be considered.

Snow depth during the winter of 1972-73 was nearly as great as

Table 16. Survival counts from game management units on the Kenai Peninsula, 1973¹.

Unit or Subunit	Date	Sample Size	Calf Percentage in Herd
15A ²	Feb. 26	202	5.4
15A ²	Feb. 27	77	5.2
15A	April 24	304	7.9
15A	May 10	142	6.5
15A	May 16	149	10.1
15B	May 11	92	16.3
15C	Feb. 22	289	16.3
15C	Mar. 30	37	16.2
15C	May 11	149	16.1
7	May 8	56	7.1

¹Bulls were not distinguished in survival counts.

²Counts made in the immediate area of Moose Research Center.

experienced during the winter of 1971-72 when high calf mortality (90 percent +) occurred on the Kenai Peninsula (Franzmann and Arneson, 1973). In the winter of 1972-73 snow depths varied considerably on the Kenai and they decreased to the west and south of the Moose Research Center in the direction of movement of moose through this area. At the time of our survival counts in the Moose Research Center area the majority of the moose had drifted to the west and south into areas where survival was higher. In the area around the Moose Research Center we may have been observing stragglers from this drift which contributed to lower survival counts. The greater snow depths in the Moose Research Center area for the winter of 1972-73 could have influenced the drift as well as the resulting poor survival, particularly when the moose are somewhat dependent upon ground cover forage (*Vaccinium vitis-idaea*) for winter survival (LeResche and Davis, in press). This same reasoning could explain the total calf mortality within the Moose Research Center enclosures where the moose were retained in the greater snow-depth area and where decreased availability of ground cover forage and cratering activity were evident.

The differences between units and subunits in percent survival cannot necessarily be explained on this same basis, but the same influences cannot be rejected. More intensive survival counts should be made to eliminate distributional bias in areas to be compared and the resulting data should be stratified in relation to moose density.

The importance of snow condition along with the timing of snowfall was demonstrated when calves were observed to spend 20.5 hours feeding in craters, and 30.8 hours browsing. To devote this proportion of feeding time to crater-feeding requires considerable expenditure of energy in digging through snow to obtain ground forage. The possibility exists also that there is a negative energy relationship associated with crater feeding. Extensive crater feeding, as observed within the Moose Research Center pens, does not appear to be the general pattern for other areas on the Kenai. It may, however, be an indicator of excessive moose density and problems of food availability that are surfacing with possible higher densities and year-round retention of moose at the Moose Research Center. Cratering activity should be monitored closely in areas of suspected high density or concentration of moose.

RECOMMENDATIONS

1. The importance of cratering activity in total feeding activity was demonstrated. Studies related to this should be continued and expanded. The energy expended by cratering to obtain ground forage should be investigated.

2. Observations of orphan and nonorphan survival should be continued and hopefully major influences such as snow depth will not override other influences to be considered such as stress associated with introduction and penning, and habitat dynamics.

3. Increased utilization of aerial survival counts in the spring should be incorporated into management plans on critical moose range.

LITERATURE CITED

- Altmann, M. 1958. Social integration of the moose calf. Anim. Behaviour 6(3 and 4):155-159.
- Berg, W. E. and R. L. Phillips. 1972. Winter spacing of moose in northwestern Minnesota. Proc. 8th N. Am. Moose Conf. and Workshop, Thunder Bay, Ont. pp. 166-178.
- Burris, O. and D. E. McKnight. In press. Game Transplants in Alaska. Alaska Dept. of Fish and Game Wildlife Technical Bulletin.
- Franzmann, A. W. and P. D. Arneson. 1973. Moose report. Annual Proj. Segment Rep. Fed. Aid in Wildl. Restoration. Alaska Dept. of Fish and Game.
- Goddard, J. 1970. Movements of moose in heavily hunted area of Ontario. J. Wildl. Manage. 34(2):439-445.
- Houston, D. B. 1968. The Shiras moose in Jackson Hole, Wyoming. Grand Teton Natur. Hist. Assoc. Tech. Bull. 1. 110 pp.
- LeResche, R. E. and J. L. Davis. 1971. Moose report. Annual Proj. Segment Rep. Fed. Aid in Wildl. Restoration. Alaska Dept. of Fish and Game.
- _____. In press. Importance of non-browse foods to moose. J. Wildl. Manage.
- Van Ballenberghe, J. and J. M. Peek. 1971. Radio telemetry studies of moose in northeastern Minnesota. J. Wildl. Manage. 35(1):63-70.

PREPARED BY:

David C. Johnson
Temporary Game Biologist

APPROVED BY:

Frank Jones
Director, Division of Game

SUBMITTED BY:

Karl B. Schneider
Regional Research Coordinator

Donald E. McKnight
Research Chief, Division of Game