ALASKA DEPARTMENT OF FISH AND GAME
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DEVELOPMENT AND TESTING OF NEW TECHNIQUES FOR MOOSE MANAGEMENT

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State: Alaska

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Project Title: Big Game Investigations

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Job Title: Development and Testing of New Techniques for Moose Management

Period Covered: July 1, 1969 to June 30, 1974

SUMMARY

Succinylcholine chloride (Anectine) was administered to 1,098 moose with 70.1 percent (770) of these becoming immobilized. Mortality rate was 4.1 percent. Dosage varied with season and condition of moose. Mean induction time was 8.5 minutes and mean time immobilized was 25.8 minutes. Hyaluronidase used with succinylcholine chloride decreased induction time by 33 percent, but mortality rates were slightly higher (4.2 vs 4.0%). This drug was the primary immobilizing agent used at the Kenai Moose Research Center (MRC) because it met most of the requirements for our use.

Etorphine (M-99) with diprenorphine were considered safer and more effective in immobilizing moose, but their use was restricted by Bureau of Narcotics and Dangerous Drug regulations. They were used only on moose within the enclosures. Satisfactory dosage of etorphine was 6.8 mg/adult (.86 mg/45 kg), 3.6 mg/yearling (.63 mg/45 kg), and 2.9 mg/calf (.86 mg/45 kg). Diprenorphine dosage is recommended at two times etorphine immobilization dose. Etorphine was the only immobilizer used on calves and it provided satisfactory results. Multiple doses to effect are not recommended.

Other drugs tested had qualities not desirable for MRC use, but under other conditions may be useful. Most of these drugs were discontinued for routine use due to prolonged recovery time.

Trapping moose was an integral part of the MRC activity. Trap design and implementation information was published (LeResche and Lynch 1973). Trapping success at the MRC was influenced by density of moose, location of trap, season and moose movement and behavior. The trap success index inside the MRC enclosures was 0.20 and outside 0.18.

Results of the aerial-count-census evaluation study were published (LeResche and Rausch 1974). Aerial composition count evaluation was not done due to lack of yearlings and calves within the MRC enclosures. Helicopter surveys of the MRC enclosures in June provided useful productivity data, but for time and money expended were not considered applicable elsewhere.

Pellet count census evaluation studies were conducted over a four-year period in Pen 1 with known numbers of moose. Pellet groups were randomly distributed in each of seven vegetation types. The hypothesis of no difference among habitat types was rejected ($a=0.01$). On this basis, the number of pellet groups per type was summed to obtain a stratified estimate of the number of pellet groups in Pen 1. Pellet groups/moose/day from 20.2 to 28.7 calculated from known moose days in the pen were much higher than those reported for other ungulates. Overestimation of moose numbers in the enclosure by factors of 1.8 to 2.7 was experienced using a reported daily moose defecation rate of 10.7. With this disparity of values and limited data on defecation rates/moose/day we were unable to validate the technique. Determining winter defecation rates, by observation, of moose at the MRC must be accomplished. The distribution of pellet groups, in broadly classified vegetation types, corresponded to reported and observed habitat use.

Telemetric tracking, utilizing radio transmitters in the 30 megahertz (mhz) range, was used to locate individual moose within the enclosures with good success, but much effort. The application of uni-directional receivers from the ground was limited, and this equipment would be inadequate for projects that require locating many animals over a short period of time. Biotelemetric procedures and equipment were investigated and their application to the MRC program was determined to be valid and proposals were prepared on this basis.

Having experienced undesirable side affects with various rumen sampling procedures we recommend that attempts with the stomach tube should utilize a portable suction pump in place of hand pump, incorporate an effective tranquilizer with the immobilizing drug and only animals in good condition be selected for sampling.

Various marking devices have been utilized on moose at the MRC and in conjunction with the Kenai Moose Population Identity Study. When individual identification of the animal was desired, the collar presently being used was considered best. It is a canvas-web collar 15.3 cm wide with a 12.7 cm numeral in contrasting color placed on top and on each side. A weight (bolts) helped retain the collar in the proper position. Eartags with colored plastic material proved useful for additional identification. Freeze-branding attempts of various types were unsuccessful on moose.

A weighing device combining a winch and tripod proved effective for moose at the MRC.

CONTENTS

BACKGROUND

Moose (*Alces alces*) research and management require methods of estimating numbers and of handling, marking and following animals. These techniques necessarily vary with species and location of the management/research problem. The Kenai Moose Research Center (MRC), with known numbers of confined animals, provides a unique test-ground for numbers-related techniques and for methods and equipment whose effectiveness can only be evaluated by relocation of the animal. Developments in many fields provided drugs, equipment and procedures potentially applicable to moose management and determined the thrust of activity under this job objective. Techniques tested and evaluated under this project since 1969 include; immobilization with drugs, trapping, aerial census, pellet count census, telemetric tracking, biotelemetry, rumen sampling, marking and weighing. Project progress reports have presented results in these areas (LeResche 1970, LeResche and Davis 1971, LeResche et al. 1973, and Franzmann and Arneson 1973). In addition several publications have emanated from these investigations (LeResche and Lynch 1973, LeResche and Rausch 1974, Franzmann and Arneson 1974, and Arneson and Franzmann 1974). This final report provides an appraisal of these studies.

An ideal immobilizing drug should possess the following qualities: 1) short induction time, 2) wide tolerance range, 3) rapid reversibility and 4) no lasting or cumulative side effects and should leave meat consumable by a subsequent hunter (LeResche and Davis 1971). Testing new drugs against these criteria should be done as they become available. Progress in large ungulate immobilization has been made as new drugs have been developed, but most fail to meet all the ideal criteria.

Succinylcholine chloride (Anectine-Burroughs, Wellcome and Co., Research Triangle Park NC) has been utilized for Cervidae immobilization for some time (Buechner et al. 1960, Talbot and Lamprey 1961, Pistley and Wright 1961, Boyd 1962, Cowan et al. 1962, Flook et al. 1962, Bergerud

et al. 1964, Harthoorn 1965, Harper 1965, White 1967, Miller 1968, Houston 1969, LeResche 1970, LeResche and Davis 1971, VanBallenberge and Peek 1971 and Franzmann and Arneson 1973). Succinylcholine chloride continues to be used in free-ranging Cervidae in spite of its narrow tolerance range, irreversibility and delayed hypersensitivity because it is considered safe to use in consumable animals and is readily available.

Etorphine (M-99 American Cyanamid Co., Princeton, NJ) incorporates most of the desired qualities of an immobilizing drug, and has the added benefit of an available and effective antagonist - diprenorphine (M 50-50, American Cyanamid Co., Princeton, NJ). However, both drugs come under registration of the Bureau of Narcotics and Dangerous Drugs which creates supply and administrative problems.

Etorphine and diprenorphine have been used on a variety of Cervidae (Harthoorn 1965, Wallach et al. 1967, Houston 1970, LeResche 1970, LeResche and Davis 1971, Franzmann and Arneson 1973, Woolf et al. 1973). Peinaar (1968a,b) reported in detail on effects of various thebaine derivatives when used alone and in combination with tranquilizers and parasympatholytic agents. Alford et al. (1974) summarized 1,600 reports on field use of etorphine and diprenorphine from 131 investigators, including MRC reports on Alaskan moose.

Other immobilizing drugs used for Cervidae include; phencyclidine hydrochloride[1] (Kroll 1962 and LeResche and Davis 1971), propriopromazine hydrochloride[2] (LeResche and Davis 1971), pentobarbital sodium (LeResche and Davis 1971), xylazine[3] (Hime and Jones 1970, Amand et al. 1971, LeResche and Davis 1971, Mulling and Henning 1971, Thurmon et al. 1972, York and Huggins 1972, and Franzmann and Arneson 1973) and CI-744[4] (Beck 1972 and Franzmann and Arneson 1973). Phenothiazine derivative tranquilizers[5,6] have been used in conjunction with immobilizing agents to supplement their action, and enzymes, such as hyaluronidase[7], have been added to speed absorption (LeResche and Davis 1971).

Need to capture and recapture moose for marking and serial blood sampling necessitated the design of a suitable trap. Taber and Cowan (1969) have reviewed designs of traps for various game animals. A fence line trap for moose was designed and described (LeResche and Lynch 1973).

Aerial censusing is at present the only practical method of estimating moose numbers in most of Alaska (cf: Rausch and Bratlie 1965, Rausch and Bishop 1968, Bishop 1969, and Rausch 1971), but the extent to which this method underestimates numbers has been a major problem when absolute numbers are sought. Siniff and Skoog (1964) developed a random stratified, quadrat sampling method for caribou (*Rangifer tarandus*), but even in intensively counted quadrats some animals were missed. Evans et al. (1966) used a similar technique on moose. Benson (1966) and Bergerud (1968) have reviewed aerial censusing techniques. The

1. Sernylan - Bio-Ceutic Laboratories, Inc., St. Joseph, MO
2. Tranvent - Diamond Laboratories, Inc., DesMoines, IA
3. Rompun - Chemagro, Dansas City, MO
4. CI-&44 - Park, Davis and Co., Detroit, MI
5. Sparine - Wyeth Laboratories, Philadelphia, PA
6. Acepromazine - Ayerst Laboratories, New York, NY
7. Wydase - Wyeth Laboratories, Philadelphia, PA

presence of four one-square-mile enclosures with known numbers of moose provided an opportunity to test this population estimation technique for moose. Results of this experiment at the MRC have been formally published (LeResche and Rausch 1974).

Known sex and age composition at the MRC provided an additional opportunity to test observers' abilities at aerial composition counts. Rausch and Bratlie (1965) outlined procedures to assess the dynamics of moose populations, and sex and age composition counts were an integral part of the procedure. Most agencies involved in moose management depend upon sex and age composition counts to evaluate the status of moose populations, and several published studies have incorporated composition counts (Edwards and Ritcey 1958, Pimlott 1959, Peek 1962, Simkin 1965, Houston 1968, Stevens 1970). Observer accuracy has not been tested and an experiment was designed at the MRC to accomplish this.

Pellet count census techniques have been used for various species of big game animals for some time (Bennet et al. 1940, Rasmussen and Doman 1943, Bowden et al. 1969). Several studies have been done with penned ungulates (Eberhardt and VanEtten 1956, Julander et al. 1963, Downing et al. 1965 and LeResche 1970, LeResche and Davis 1971 and Franzmann and Arneson 1973), and others have used the technique in habitat use studies (DesMeules 1962). Data regarding distribution of pellet groups are quite variable; however, most observers have found that they tend to be aggregated. Loveless (1967) found that mule deer (*Odocoileus hemionus*) pellet groups on north facing slopes tended to be randomly distributed while those occurring on south and west facing slopes tended to be contagiously distributed. Bowden et al. (1969) compared the distribution of mule deer pellet groups with four mathematical distributions. The Poisson distribution, which would represent a random placement of pellet groups, did not fit their data. All three contagious distributional models (negative binomial, Thomas, and Neyman Type A) fit the data.

The problems and promise of biotelemetry in behavior and physiology related to ecological problems were outlined in the 1960's (Slater 1963, and MacKay 1968). Advances and achievements in the field coincided with technological advances. Will and Patric (1972) compiled a bibliography on wildlife telemetry which lists over 450 references. Gessaman (1973) reviewed some applications of telemetry to homeotherm energetics in a view compatible with ecological modeling.

Telemetric tracking of moose has been utilized at the MRC (LeResche and Davis 1971, and Johnson et al. 1973) and in Minnesota (Van Ballenberghe and Peek 1971, and Berg and Phillips 1972). Current studies in Interior Alaska by John Coady, Alaska Department of Fish and Game, are utilizing telemetric tracking.

Biotelemetry studies are lacking in moose, but have been utilized in other mammals to obtain heart rates from Artic fox (*Alopex lagopus*), Artic wolf (*Canis lupus*), wolverine (*Gulo gulo*) (Folk 1964), European hedgehog (*Erinaceus europaeus*), Rhesus maca (*Macaca mulatta*), stump-

tailed macaque (*Macaca sylvana*), snowshoe hare (*Lepus americanus*), Artic ground squirrel (*Citellus undulatus*) (Folk and Hedge 1964), big brown bat (*Eptesicus fuscus*) (Studier and Howell 1969), Uinta ground squirrel (*Citellus armatus*) (Ruff 1971), Beldings ground squirrel, (*Citellus beldingi*), California ground squirrel (*Spermophilus beecheyi*), golden-mantled ground squirrel (*Citellus lateralis*) (Morhardt and Morhardt 1969) and white-tailed deer (*Odocoileus virginianus*) (Skutt et al. 1973). Mammalian body temperature recordings via biotelemetry have been utilized in pronghorn antelope (*Antilocapra americana*) (Lonsdale et al. 1971), yellow-bellied marmots (*Marmota flaviventris*) (Downhower and Pauley 1970), northern elephant seal (*Mirounga angustirostris*) (McGinnis and Southworth 1967), grizzly bear, (*Ursus arctos*) elk (*Cervus canadensis*) (Craighead and Craighead 1971), African elephant (*Loxodonta africana*), zebra (*Equus burchelli*), African buffalo (*Syncerus caffer*), polar bear (*Thalarctos maritimus*) (Baldwin 1973), Mexican wolf (*Canis lupus baileyi*) (Williams et al. 1968), kongoni (*Alcelaphus caama*), eland (*Taurotragus oryx*) (McGinnis et al. 1970), and white-tailed deer (Skutt et al. 1973).

Johnson and Gessaman (1973), in their review on heart rate as an indirect monitor of free-living energy metabolism, concluded that monitoring heart rates of mammals throughout the day may provide a fair to good index of their average daily free-living metabolic rates.

Van Dyne (1968) reviewed techniques for measuring dietary preferences and digestibilities of foods selected by large herbivores. Previous studies at the MRC have utilized techniques involving observation of free-ranging animals (LeResche and Davis 1973), estimating food intake by observing browsed plants (LeResche and Davis 1971 and Oldemeyer 1974), rumen contents analyses of hunter-harvested animals (LeResche and Davis 1971), fecal analysis (LeResche et al. 1973) and *in vitro* digestibility trials (Oldemeyer 1974). *In vivo* digestibility trials required rumen-fistulated animals. Rumen fistulation was performed on two moose (LeResche et al. 1973). *In vitro* digestibility trials required obtaining moose rumen liquor. Rumen sampling from elk and deer utilizing a rumen trocar technique was reported by Follis and Spillett (1972). Rumen sampling with a stomach tube and pump is a procedure regularly utilized in the practice of veterinary medicine. A method to obtain rumen liquor for *in vitro* digestion trials in an efficient manner without sacrifice of the individual was required.

Various methods for marking wild animals were reviewed by Taber and Cowan (1969). Methods for marking moose for subsequent identification have stressed assorted collars, pendants and earflags. Color-coded collars, as described by LeResche and Davis (1971), were replaced by a combination color-coded and numbered collar for Kenai Peninsula population identity studies (Franzmann and Arneson 1973). In work with domestic animals, freeze-branding (Farrell et al. 1969 and Kambitsch et al. 1969) has been generally accepted as a marking technique. The method involves killing pigment-producing cells in hair follicles by freezing, thereby producing white hair in the pattern of the brand applied. Dye-marking moose by aerial bombardment or with Cap-Chur dye projectiles may supplement other marking techniques.

The MRC provided an opportunity to serially handle many moose and road access was available to nearly all 21 traps most of the year. The desirability of obtaining weights necessitated developing equipment and methods for weighing large cervids.

OBJECTIVES

To test and evaluate techniques that are potentially useful for determining population status, movements and other factors necessary for management of moose.

PROCEDURES

Immobilizing Drugs

Immobilizing drugs, both commercially available and experimental, were tested on moose at the MRC for their induction time, tolerance range, reversibility, side effects and general effectiveness. Drugs tested included; succinylcholine chloride, etorphine with diprenorphine, phencyclidine hydrochloride, propriopromazine hydrochloride, pentobarbital sodium, xylazine, and CI-744. In most instances the drugs were administered with Cap-Chur equipment (Palmer Chemical, Douglasville GA). Drugs to supplement the effectiveness of immobilizing agents, such as tranquilizers and enzymes, were also tested.

Trapping

The design and development of traps for moose at the MRC have been reported by LeResche and Lynch (1973). Trap effectiveness was monitored by recording trap nights, moose processed, moose released, moose escaped and malfunctions. A trap success index was computed from this for both inside and outside traps on an individual trap and monthly basis.

Aerial Census Evaluation

From January 26 - February 4, 1970, three helicopter counts and 19 counts by PA18-150 "Supercubs" were made of moose in the four Kenai Moose Research Center pens. Thirty-three additional "Supercub" counts were made on March 6-9, 1971. Observers were instructed to direct pilots how to fly the survey and were allowed 15 minutes to count each square mile. Pilots did not participate in locating moose and observers recorded each moose seen. Observers could direct pilots to circle over one small area, to fly transects and in general follow their requests within the time constraints.

Conditions were good to excellent, with snow cover at least adequate, for 15 counts in 1970 and poor for 4 counts that year. Conditions were excellent, with complete snow cover, during all 1971 counts.

Time of day, pilot and previous moose counting experience of each observer were noted and the total number of moose seen in each pen was recorded.

Helicopter surveys to assess the MRC populations were done periodically. Time spent per pen and proportion of moose observed to moose known present were recorded.

Pellet Count Census Evaluation

One hundred and sixty (159 in winter 1970-71) 17.9 m^2 permanent browse utilization plots in Pen 1 were used for pellet group count plots. Plots were randomly located in each of seven vegetative types representing 204.3 ha of the 241.1 ha in Pen 1. The sample plots constituted 0.14 percent (0.139 in 1970-71) of the area utilized. The non-sampled area of 36.8 ha consisted of spruce-*Ledum*, grass, sedge and water areas which were not considered winter use areas based upon winter feeding preferences of three tame moose on natural forage (LeResche and Davis 1973).

Plots were cleared of pellets in May 1970 and were first counted and cleared again on June 2-4, 1971. Fecal deposits in each plot were classified as winter (pelletized) or summer (not-pelletized). Based on observations of the MRC trapped moose, the period of pelletized fecal groups was established as beginning November 1 and continuing until June 1. No plots were counted or cleared in spring 1972. On May 10, 11, 14 and 18, 1973 the 160 plots in Pen 1 were again counted and cleared. Separation of past year from present year groups was attempted on the basis of leaf and duff cover over pellet groups, deterioration of pellet groups and color and texture of these groups. The leaf cover use was enhanced by the fact that leaves fall during early October in this area prior to pelletization of moose fecal droppings (November 1). On May 6, 7, and 8, 1974 the plots were counted and cleared with only winter-summer separation made as plots had been cleared the previous May.

Moose days were calculated for the four winter periods in Pen 1 based upon the 210-day (November 1 to June 1) pellet forming period and known numbers of moose present either for the entire period or parts thereof. We considered this an accurate appraisal of moose numbers in Pen 1 as moose were trapped and observed throughout this period. The winters of 1972-73 and 1973-74 had 196 and 191 potential moose days respectively since the plots for each period were counted prior to June 1 when pellet formation generally ceased.

Telemetric Tracking

Radio transmitters in the 30 mhz range were placed on eight cow moose in the spring of 1970. Similar equipment was placed on six calves and six cows for a behavior and survival study of orphaned and non-orphaned moose calves in fall 1972 (Johnson et al. 1973). A hand-held directional receiver (D11/m) was used in both studies to locate radio-collared moose from the ground. Transmitters and receiver components were obtained from Boyd's Hobby Shop, Tumwater, WA. The transmitters were incorporated into cow and calf collars at the MRC.

Biotelemetry

Investigations into equipment, procedure and application of biotelemetry equipment were completed and a biotelemetry and radio tracking study plan was outlined. The objectives of this plan were: 1) to delineate diurnal and seasonal movements and associated behavior patterns via radio telemetry of moose, 2) to assess the physiologic response and evaluate the stress associated with basic, nonbasic and abnormal activity patterns of moose, both naturally occurring and induced, via biotelemetry, 3) to indirectly monitor free-living energy metabolism of moose via biotelemetry and 4) to assist ongoing studies of reproduction, productivity, natality and mortality of moose. Hugh Martin from Oceans Applied Research Corp., San Diego, CA, visited the MRC in March, 1974 to determine the equipment that would be required.

Rumen Sampling

Rumen liquor was obtained for *in vitro* digestion trials by rumen trocar and a stomach tube using hand and mechanical pump methods (Franzmann and Arneson 1973). To obtain rumen samples for food habits and *in vivo* digestion trials rumen fistulae were implanted in two moose (LeResche et al. 1973). Rumen samples were also obtained from salvaged moose and from those animals collected for volatile fatty acid (VFA) studies.

Marking Techniques

Collars:

Collaring began within the enclosures at the MRC in January 1968. The first collars used consisted of braided polyethlene rope with colored Saflag material (Safety Flag Co. of America, Pawtucket, RI) woven into the collar in six locations. At the bottom of these collars was a numbered flex nylon cattle marker (Nasco, Fort Atkinson, WI).

Moose captured and tagged in Mystery Creek drainage in October 1968 were fitted with solid color canvas-web collars (Denver Tent and Awning Co., Denver, CO) that were 10 cm wide. Colors denoted whether the moose was male or female. Male collars were 132 cm. long and open with three grommets in each end to fasten with bolts, clips or rings at the time of tagging. Female collars were 107 cm long, sewn closed with one grommet for attaching a weight. During 1968 and 1969 these same type collars were used on moose within the enclosures at the MRC. Beginning in August 1969 moose trapped outside the enclosures at the MRC had white collars placed on females and blue collars on males.

In early 1970 numbers 9 cm high were written on the solid collars with a "magic marker" for further identification. Red pendants 13 by 18 cm with white 8 cm high by 8 mm wide letters and numerals were suspended from collars in June 1970 to identify moose as individuals when seen from a "Supercub". Numbers were routed on both sides of the laminated plastic pendants and hung either perpendicular or parallel to the moose's longitudinal axis. Similar pendants, white with black numerals, were placed on collars of moose trapped at the MRC.

In May 1971 canvas-web collars, each with a unique stripe combination (Fig. 1), were placed on free-ranging moose. These collars also carried numbered pendants as mentioned above. After January 1972 at the MRC and in October 1972 in Big Indian Creek and Skilak - Tustumena Benchland, moose were marked with quadracolor collars to be distinguishable as individuals (Fig. 2). Since July 1973 collars 15.3 cm wide with numerals 12.7 cm high (Fig. 3) have been used on free-ranging and inside MRC moose.

Eartags:

The first eartags utilized were metal, ear-piercing, Hasco tags (National Band and Tag Co. Newport, KY) with Saflag streamer material (Saflag Co. of America, Pawtucket, RI) 7.6 cm wide x 22.9 cm long in various colors. In 1970 and 1971 large-sized, black Ritchey eartags (Nasco, Fort Atkinson, WI) with white letters and numerals and various colored jumbo Rototags (Dalton Supplies Ltd. Henley-on-Thames, Nettlebed, England) were tested for permanence, legibility and ease of installation. Goliath Rototags (Dalton Supplies Ltd., Henley-on-Thames, Nettlebed, England) were used on free-ranging moose marked in October 1972 and 1973. At the MRC silver Saflag material in the right ear of females and left ear of males fastened with metal Hasco tags has been used from May 1970 to date.

Freeze-Branding:

On November 10-11, 1970 two tame 17-month-old male moose (Walter and Richard) were freeze-branded. Hair was shaved with electric animal clippers and cold copper branding "irons" were applied to the skin. Numbers were 15.3 cm high and approximately 2.5 cm wide (L&H Mfg. Co., Mandan, SD). Irons were cooled with a mixture of acetone and dry ice and applied for varying lengths of time.

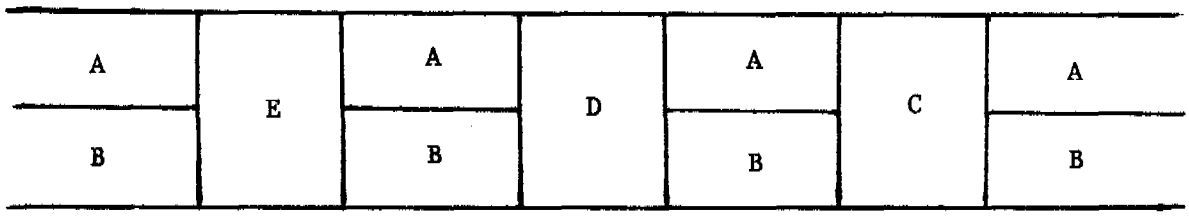
Freeze-branding with a spray-on refrigerant (Cryokwik, International Equipment Co., Needham Heights, MA) was attempted on March 27, 1973. One area on the left flank of Wally, Jr., our semi-tame moose, was clipped and sprayed for 20 seconds. The right flank was sprayed for 20 seconds without clipping the hair, and an area on the rump was sprayed for 20 seconds after parting the hair.

A modified freeze-branding technique, as outlined by R.K. Farrel, Endoparasite Vector Pioneering Research Laboratory, Pullman, WA (personal communication), was also attempted on Wally, Jr. The procedure utilized Freon 12 and Freon 22 gas in pressurized cans and stainless steel "cookie cutter" devices, one rectangular and one "L" shaped. The area to be branded was clipped and the "cookie cutters" were held against the skin on a horizontal area to produce a pool when sprayed with the Freon. Areas were sprayed for varying periods of time and some were quickly thawed, others were not.

Weighing

A note as submitted for publication appears in Findings section.

Fig. 1. Canvas-web collars placed on moose, with colored plastic tape for individual identification.



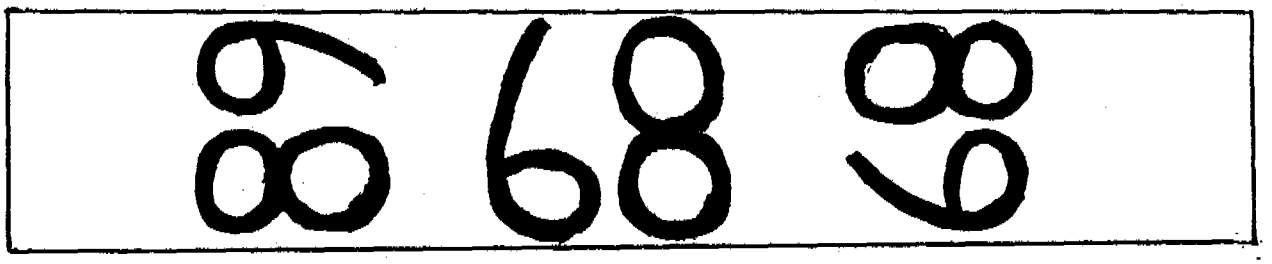
A Females: Pink, Red; Males: Yellow, Orange
B Females: Red, Pink; Males: Orange, Yellow
C Tape: Green, Brown, Black, Silver, Yellow, Blue, White
D Tape: Green, Brown, Black, Silver, Yellow, Blue, White
E Tape: Green, Brown, Black, Silver, Yellow, Blue, White

Fig. 2. Design of quadracolor canvas-web collars to identify tagged moose as individuals.

Panel 1	Panel 2
Panel 3	Panel 4

Panels consist of any combination of the following colors: red, yellow, blue, white, pink.

Fig. 3. Design of 15.3 cm canvas-web neck collars used to identify tagged moose as individuals.



Background and number color varies with tagging site. Numbered 1-99.

FINDINGS

Immobilizing, Reversing and Adjunct Drugs

Evaluation of moose immobilizing, reversing and adjunct drugs was accomplished and new drugs were tested and evaluated as they became available.

Succinylcholine chloride: This drug was the primary immobilizing agent used at the MRC since 1968 because it met most of our requirements for an ideal ungulate immobilizer. It had a relative short induction time with no lasting or cumulative side effects and the meat from immobilized animals was considered consumable in a relatively short time following recovery. Limitations were its low tolerance range and irreversability.

Tables 1, 2 and 3 list the dosages of succinylcholine chloride used in concentrations of 10 mg/cc with and without the enzyme hyaluronidase (9 N.F. units hyaluronidase/mg succinylcholine chloride) for moose trapped within the MRC enclosures, trapped outside the MRC enclosures and free-ranging. Table 4 contains condensed data from Tables 1,2 and 3. The total number of moose immobilized was 722 and the mean induction time was 8.5 minutes (Table 4). Mean immobilizing time (n = 463) was 25.8 minutes (Table 4).

Induction time was shortened with the use of hyaluronidase by a mean time of 2.3 minutes for all observations (Table 4). This figure may be biased in that the recorded induction times for some of the free-ranging moose (Table 3) were longer than actually experienced due to the inability of observers to see the animal go down in every case. Often the down time was recorded when the animal was found or observed down, which was often several minutes after the animal went down. Eliminating the free-ranging induction times and utilizing only the inside and outside MRC induction times (Tables 1 and 2), where the observer could accurately record induction time, adult moose experienced a mean induction time decrease of 3.4 minutes with hyaluronidase. The mean induction time for male moose without hyaluronidase was 9.5 minutes and with hyaluronidase 6.2 minutes, and for female moose the respective mean induction times were 10.2 and 6.8 minutes (total sample - 402). Male moose mean induction time was less than females by 0.7 minutes without hyaluronidase and 0.6 minutes with hyaluronidase (Tables 1 and 2).

The addition of hyaluronidase to succinylcholine chloride provided a definite induction time advantage (33% shorter), and this can be critical, particularly when working with free-ranging animals. However, mortality risk may be slightly greater. Percent of moose killed of moose darted was 4.0 for 479 moose given succinylcholine chloride with hyaluronidase (Table 5). When we remove the Moose River Flats (May 1971) group from the data the percentage with succinylcholine chloride alone drops to 1.5 for 400 moose. This group was removed for discussion in that extremely high mortality was experienced for this group and it was speculated at the time that the physiologic state of the animals at parturition may have been responsible. To further substantiate the possible increase in mortality risk by using hyaluronidase, we compared

Table 1. Effects of succinylcholine chloride (Anectine)[a.] and hyaluronidase (Wydase)[b.] administered to trapped adult Alaskan moose within the Kenai Moose Research Center (MRC) enclosures July 1, 1969 to May 1, 1974. (Sample size in parenthesis).

Dosage (mg of Anectine)	Mean Induction Time (min.)				Mean Time Immobilized (min.)			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
13	0	8.0(1)	0	6.0(1)	0	10.0(1)	0	14.0(1)
13.5	7.5(3)	10.6(23)	2.5(1)	8.3(13)	41.5(3)	20.4(23)	22.0(1)	34.4(12)
14	9.1(7)	8.9(9)	4.5(1)	5.2(5)	9.1(7)	18.6(9)	14.1(1)	20.0(5)
15	9.7(3)	9.0(1)	0	6.0(1)	15.7(3)	25.0(1)	0	17.0(1)
15.5	0	10.5(2)	8.0(1)	0	0	16.5(2)	27.0(1)	0
16	9.0(2)	0	6.0(1)	6.0(1)	26.0(2)	0	21.0(1)	31.0(1)
17	6.3(3)	0	21.0(1)	0	19.3(3)	0	7.5(1)	0
17.5	0	0	0	9.0(1)	0	0	0	21.0(1)
18	10.5(2)	8.4(4)	6.3(18)	7.6(17)	15.0(1)	19.8(4)	25.1(15)	26.1(14)
18.5	0	0	18.0(1)	0	0	0	39.0(1)	0
19	6.5(2)	7.2(6)	5.2(6)	6.6(28)	38.5(2)	30.3(6)	26.0(5)	30.8(23)
20	15.0(2)	12.6(5)	3.8(3)	6.4(14)	17.8(2)	22.9(4)	32.3(2)	32.8(13)
21	8.0(1)	10.7(6)	7.0(3)	6.6(15)	31.0(1)	30.0(6)	28.0(2)	28.9(14)
21.5	0	0	4.0(1)	0	0	0	44.0(1)	0
22	0	10.8(9)	11.0(1)	4.9(13)	0	27.9(9)	18.0(1)	32.7(13)
23	0	11.1(13)	0	0	0	30.6(13)	0	0
24	19.0(1)	0	0	0	34.0(1)	0	0	0
Mean	9.4(26)	10.2(79)	6.4(38)	6.6(110)	21.5(25)	24.2(78)	25.6(32)	29.9(98)
Sex Combined Mean	10.0(105)		6.5(148)		23.5(103)		28.8(130)	
Sex and Drug Combined Mean	8.0(253)				26.5(233)			

a. Anectine - Burroughs Wellcome and Co., Research Triangle Park, NC.
b. Wydase - Wyeth Laboratories Inc., Philadelphia PA - 9 NF units Wydase per mg Anectine.

Table 2 Effects of succinylcholine chloride (Anectine)[a] and hyaluronidase (Wydase)[b] administered to trapped adult Alaskan moose outside the Kenai Moose Research Center (MRC) enclosures. July 1, 1969 to May 1, 1974 (Sample size in parenthesis).

Dosage (mg of Anectine)	Mean Induction Time (min.)				Mean Time Immobilized (min.)			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
12.5	0	12.0(1)	0	0	0	34.0(1)	0	0
13	0	12.8(5)	0	0	0	22.4(5)	0	0
13.5	10.0(1)	13.3(3)	0	15.0(1)	37.0(1)	12.3(3)	0	23.0(1)
14	19.0(1)	11.5(2)	0	3.0(1)	25.0(1)	27.0(2)	0	12.0(1)
15.5	10.0(1)	0	0	9.0(2)	20.0(1)	0	0	14.5(2)
16	0	11.0(1)	0	0	0	14.0(1)	0	0
18	5.0(1)	6.0(4)	5.5(2)	6.5(15)	32.0(1)	21.8(3)	25.5(2)	25.8(15)
19	6.0(1)	0	5.3(3)	5.6(21)	35.0(1)	0	33.3(3)	30.1(20)
20	0	7.9(10)	6.5(2)	6.5(20)	0	34.5(9)	22.5(2)	25.6(20)
21	0	10.0(6)	5.0(2)	9.6(8)	0	29.2(6)	26.0(2)	29.0(6)
22	0	9.8(14)	6.0(1)	10.1(10)	0	24.8(13)	2.0(1)	0.9(10)
23	0	15.5(4)	0	5.1(5)	0	30.5(4)	0	35.4(5)
24	0	0	0	7.5(1)	0	0	0	17.0(1)
Mean	10.0(5)	10.2(50)	5.6(10)	7.0(84)	29.8(5)	26.6(47)	30.0(10)	26.4(81)
Sex Combined Mean	10.2(55)		6.9(94)		26.9(52)		26.8(91)	
Sex and Drug Combined Mean	8.1 (149)				26.8(143)			

a. Anectine - Burroughs Wellcome and Co., Research Triangle Park NC.
b. Wydase - Wyeth Laboratories Inc., Philadelphia PA - 9 NF units Wydase per mg. Anectine.

Table 3. Effects of succinylcholine chloride (Anectine)[a] and hyaluronidase (Wydase)[b] administered to free-ranging adult Alaskan moose. October 1968 through March 1974. (Sample size in parenthesis).

Dosage (mg of Anectine)	Mean Induction Time (min.)				Mean Time Immobilized (min.)			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
20	10.6(6)	11.3(10)	9.1(28)	8.9(18)	9.0(1)	30.3(4)	19.9(10)	26.5(2)
21	7.2(14)	9.1(28)	9.9(25)	9.3(26)	14.3(3)	36.0(2)	21.5(13)	18.6(5)
22	0	9.8(9)	8.1(12)	7.5(51)	0	17.2(4)	0	25.8(8)
22.5	13.5(2)	5.7(3)	0	0	0	0	23.0(2)	0
23	10.8(8)	9.7(17)	6.4(7)	8.4(27)	40.0(1)	10.7(3)	0	23.3(13)
23.5	0	14.4(5)	0	0	0	20.5(4)	0	0
24	0	0	0	9.2(14)	0	0	0	23.8(4)
24.5	12.0(1)	15.0(1)	0	0	30.0(1)	25.0(1)	0	0
25	8.0(1)	8.2(5)	0	0	0	30.8(5)	0	0
25.5	13.0(1)	4.0(1)	0	0	0	16.0(1)	0	0
Mean	9.4(33)	917(79)	8.9(72)	8.5(136)	20.3(6)	23.8(24)	20.2(25)	23.5(32)
Sex Combined Mean	9.6(112)		8.6(208)		23.1(30)		22.1(57)	
Sex and Drug Combined Mean	9.0(320)				22.4(87)			

a. Anectine - Burroughs Wellcome and Co, Research Triangle Park, NC.
b. Wydase - Wyeth Laboratories Inc., Philadelphia PA - 9 NF units Wydase per mg of Anectine.

Table 4. Effects of succinylcholine chloride (Anectine)[a.] and hyaluronidase (Wydase)[b.] administered to Kenai Moose Research Center (MRC) inside and outside trapped and free-ranging Alaskan moose. October 1968 to May 1974. (Sample size in parenthesis).

Moose Group	Mean Induction Time (min.)				Mean Time Immobilized (min.)			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
Inside MRC	9.4(26)	10.2(79)	6.4(38)	6.6(110)	21.5(25)	24.2(78)	25.6(32)	29.9(98)
Outside MRC	10.0(5)	10.2(50)	5.6(10)	7.0(84)	29.8(5)	26.6(47)	30.0(10)	26.4(81)
Free-ranging	9.4(33)	9.7(79)	8.9(72)	8.5(136)	20.3(6)	23.8(24)	20.2(25)	23.5(32)
Mean	9.4(64)	10.0(208)	7.8(120)	7.5(330)	22.4(36)	24.9(149)	24.2(67)	27.6(211)
Sex Combined Mean	9.9(272)		7.6(450)		24.4(185)		26.8(278)	
Sex and Drug Combined Mean	8.5(722)				25.8(463)			

a. Anectine - Burroughs Wellcome and Co., Research Triangle Park, NC.
b. Wydase - Wyeth Laboratories Inc., Philadelphia, PA - 9 NF units Wydase per mg. of Anectine.

Table 5. Effects of succinylcholine chloride (Anectine)[a] and hyaluronidase (Wydase)[b] on 1098 adult Alaskan moose (1968-1974)

	Percentage Immobilized of Moose Darted				Percentage Killed of Moose Darted			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
Trapped Inside MRC[1] (1968-1974)	60.5 (26 of 43)	73.8 (79 of 107)	71.7 (38 of 53)	79.6 (109 of 137)	0 (0 of 43)	0 (0 of 107)	3.8 (2 of 53)	4.4 (6 of 137)
Trapped Outside MRC (1968-1974)	45.5 (5 of 11)	69.4 (50 of 72)	83.3 (10 of 12)	79.2 (84 of 106)	0 (0 of 11)	1.4 (1 of 72)	0 (0 of 12)	2.8 (3 of 106)
Mystery-Dike Creek (October 1968)	76.9 (10 of 13)	60.0 (18 of 30)			0 (0 of 13)	0 (0 of 30)		
Skilak-Bot Lake (March 1970)	67.0* (8 of 12*)	64.3* (36 of 56*)			8.3 (1 of 12)	3.6 (2 of 56)		
Moose River Flats (June 1970)	90.9 (20 of 22*)	82.4 (28 of 34*)			4.5 (1 of 22)	2.9 (1 of 34)		
Moose River Flats (May 1971)	61.9* (13 of 21*)	69.0* (40 of 58*)			14.3 (3 of 21)	17.2 (10 of 58)		
Funny River Strip (October 1972)			64.8 (35 of 54)	54.8 (45 of 82)			3.7 (2 of 54)	7.3 (6 of 82)
Caribou Hills (October 1973)			65.0* (32 of 49*)	65.0* (34 of 52*)			2.0 (1 of 49)	9.6 (5 of 52)
Copper River Delta (March 1974)			60.0* (12 of 20*)	70.0* (38 of 54*)			0 (0 of 20)	1.8 (1 of 54)

Table 5. Effects of succinylcholine chloride (Anectine)[a] and hyaluronidase (Wydase)[b] on 1098 adult Alaskan moose (1968-1974)

	Percentage Immobilized of Moose Darted				Percentage Killed of Moose Darted			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
Mean**	67.2 (82 of 122)	70.3 (251 of 357)	67.5 (127 of 188)	71.9 (310 of 431)	4.1 (5 of 122)	3.9 (14 of 357)	2.7 (5 of 188)	4.9 (21 of 431)
Sex Combined Mean**	69.5 (333 of 479)		70.6 (437 of 619)		4.0 (19 of 479)		4.2 (26 of 619)	
Sex and Drug Combined Mean**	70.1 (770 of 1098)				4.1*** (45 of 1098)			

1 Kenai Moose Research Center
a Anectine - Burroughs Wellcome and Co., Research Triangle Park NC
b Wydase - Wyeth Laboratories Inc., Philadelphia PA - 9 NF units Wydase per mg Anectine
* Estimated
** Estimated values not included
*** Percentage killed of moose immobilized = 5.8 (45 of 770)

our data from the MRC (Table 5). Moose trapped and immobilized within the MRC enclosures experienced no mortality with succinylcholine chloride alone (150 moose) and with hyaluronidase 8 of 190 (4.2%) died. One moose of 83 (1.2%) trapped and immobilized outside the MRC enclosures died from use of succinylcholine chloride alone and 3 of 118 (2.5%) died when hyaluronidase was added to succinylcholine chloride. Combining inside and outside trapped MRC immobilized moose, 0.4 percent (1 of 233) died from succinylcholine chloride use and 3.6 percent (11 of 308) died from use of succinylcholine chloride and hyaluronidase in combination.

These data suggest that mortality risk is increased with the addition of hyaluronidase to succinylcholine chloride and an *a priori* judgement should be made whether to forego the advantage of shortened induction time when adding hyaluronidase.

Artificial respiration was administered to at least 20 moose appearing to suffer respiratory distress at the MRC. Twelve of these moose survived.

Seasonal influence on succinylcholine chloride dosage of moose immobilized at the MRC corresponded generally to the high and low periods of moose condition. Moose condition was assessed based upon body fleshing and cover (Franzmann and Arneson 1973). In late winter and spring, when moose were in poorest condition, the dosage and induction time were lower than during the fall when moose were in peak condition (Table 6). Moose weight also fluctuates with season and it may be this factor alone was responsible for observed differences, but other physiological parameters of the animal during lowered condition certainly must not be eliminated from consideration.

The dosage of succinylcholine chloride necessary to produce immobilization is susceptible to many sources of variation, but when due consideration was given to these variables, it proved to be a useful immobilizing drug for moose at the MRC.

Etorphine (M-99) and Diprenorphine (M 50-50): Etorphine incorporates most of the desirable characteristics of an immobilizing drug. It has a relatively short induction time, a wide tolerance range and rapid reversibility with the reversing agent - diprenorphine. However, both drugs are subject to Bureau of Narcotics and Dangerous Drug regulations and have not been cleared for use in consumable animals at this time.

Since October 1969, 69 adults, 17 yearlings and 22 calves have been immobilized with etorphine and reversed with diprenorphine. Date, dosage, induction time, time immobilized and reversal time were recorded for each moose immobilized (Tables 7,8,9 and 10). An evaluation of satisfactory (s) or unsatisfactory (u) response was made for each moose immobilized with etorphine based upon induction time. An induction time of 15 minutes or longer was considered unsatisfactory. There were no "u" classifications for calves (Table 8), two for yearlings (Table 9) and 26 for adults (Table 8).

The mean total "s" adult dose (43 moose) was 6.8 mg (0.86 mg/45 kg) with a mean induction time of 7.8 minutes and a mean reversal time of

Table 6. Mean monthly succinylcholine chloride (Anectine)[1] dosage and induction time of moose at the Kenai Moose Research Center, Alaska, 1968-1974.[2]

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Dosage (mg)												
N	36	28	20	26	--	21	32	31	44	40	20	25
$\bar{X}$	21.0	19.5	18.6	18.8	--	17.7	19.9	20.1	20.3	20.4	20.1	20.5
Induction Time (min.)												
N	34	27	13	22	--	17	32	31	41	40	20	25
$\bar{X}$	7.2	6.7	7.3	6.2	--	6.7	8.6	7.2	8.1	8.2	7.3	8.6

1 Anectine - Burroughs, Wellcome and Co. Inc., Research Triangle Park, NC

2 Excluding data from March to October, 1972, and combining dosages with and without hyaluronidase.

Table 7. Satisfactory immobilization results of adult moose at the Kenai Moose Research Center, Alaska, with etorphine (M-99) and diprenorphine (M 50-50).

Animal No.	Sex	Month Year	Total Dose mg	Weight Kg	Dose mg/45 kg	Induction Time (min)	Time Immobilized (min)	Reversal Time (min)
26	F	Oct. 1969	10	--	--	4	7	4
23	F	Oct. 1969	10	--	--	8	20	1
25	F	Oct. 1969	8	--	--	9	24	2
Raquel	F	Oct. 1973	8	385*	.94	5	20	1.5
Raquel	F	Nov. 1972	5	373	.61	14	36	0.5
Raquel	F	Nov. 1972	5	373	.61	6	32	1.0
25	F	Dec. 1969	8	--	--	9	24	2
34	F	Dec. 1969	10	--	--	4.5	15	35***
Raquel	F	Dec. 1972	7	384	.83	7	32	2
45	M	Dec. 1972	7	393	.81	5	31	1
Raquel	F	Dec. 1973	8	430	.85	4	24	6
36	M	Jan. 1970	8	--	--	7	26	1
Raquel	F	Jan. 1973	7	385*	.82	5	31	1
87	F	Feb. 1973	6	365*	.75	5	40	1
Raquel	F	Feb. 1973	7	385*	.82	12	49	1
Raquel	F	Feb. 1974	8	426	.85	3.5	42	6
53	M	Mar. 1973	7	318	1.00	8	33	2
91	F	Mar. 1973	7	341*	.93	9	29	1.5
84	F	Mar. 1973	7	330*	.97	5	20	1
177	F	Mar. 1973	7	341*	.93	9	50	2
Raquel	F	Mar. 1973	7	445	.71	8	28	2
Raquel	F	Apr. 1973	7	445*	.71	8	28	2
60	F	May 1970	3	--	--	7.5	21	1.5
62	F	May 1970	4	--	--	13	10	2
60	M	May 1970	6	--	--	5	26	1.5
31	F	May 1970	4	--	--	5	10	1.5
9	F	May 1970	9**	--	--	9	23	1.0
65	F	June 1970	4.5	--	--	9	30	--
66	F	June 1970	4	--	--	13	10	1.5
R70-4	F	June 1970	5	--	--	5	12.5	1
72	F	June 1973	7	340*	.93	9	33	1
37	F	June 1973	7	365*	.88	10	19	1
10	F	June 1973	7	340*	.93	6	25	6
36	M	June 1973	8	375*	.97	13	22	2
27	F	June 1973	7	340*	.93	8	37	1
67	F	July 1970	6	--	--	11	11	--
27	F	July 1973	7	386*	.82	9	20	1
Raquel	F	July 1973	9	409*	1.00	4	30	4
Wally	M	July 1973	8	364*	1.00	4	16	1
56	M	Aug. 1971	5	248	.92	6	20	1
Raquel	F	Aug. 1971	5	--	--	10	34	2
7	M	Sept. 1971	7.5	--	--	14	4	1
59	M	Sept. 1971	7.5	-	-	12	15	12***
Mean			6.8	372	.86	7.8	25.1	2.1
SD			1.7	43	.11	3.0	10.7	1.9

* Estimated weight
** Multiple doses
*** Not calculated in mean (M 50-50 underdosed)

Table 8. Unsatisfactory immobilization results of adult moose at the Kenai Moose Research Center, Alaska, with etorphine (M-99) and diprenorphine (M 50-50).

Animal No.	Sex	Month Year	Total Dose mg	Weight kg	Dose mg/45 kg	Induction Time (min)	Time Immobilized (min)	Reversal Time (min)	Comment
6	F	Oct. 1969	11**	--	--	29	10	1	
32	F	Oct. 1969	10**	--	--	22	--	--	Died
29	F	Oct. 1969	8.5**	--	--	28 Forced down	55	3	
31	F	Oct. 1969	9**	--	--	51	28	23	
56	M	Oct. 1969	10**	--	--	55 Forced down	52	8	
53	M	Nov. 1972	5	341*	.67	19	44	1	
106	F	Dec. 1973	10**	409*	1.11	15	22	2.5	
59	F	Jan. 1970	11.5**	--	--	Did not go down			
53	M	Feb. 1973	9.5**	330*	1.31	34	63	1	
91	F	Feb. 1973	6.5	364*	.88	18	94	4	
86	F	Apr. 1971	2.5**	--		10 Forced down	10	1	
52	F	Apr. 1973	7	386*	.82	13	14 Up without M 50-50		
R70-2	F	May 1970	2	289	.31	15	17	3.5	
26	F	May 1970	6	--	--	5	--	--	Died
87	F	May 1970	6**	--	--	50 Forced down	7	6	
35	M	May 1970	4.2**	--	--	25 Forced down	10	1	
63	F	June 1970	3.5	--	--	15 Forced down	19	3	
1	F	June 1970	8.5**	--	--	34 Forced down	5	2	
9	F	July 1970	6	--	--	20	13	1.5	
R70-8	F	July 1970	6	--	--	21	14	1.5	
27	F	July 1970	6**	--	--	Did not go down			
38	F	July 1970	7**	--	--	21 Forced down	11	1	
55	M	Aug. 1971	13**	--	--	46	--	--	Died
60	M	Aug. 1971	8**	--	--	Did not go down			
Raquel	F	Sept. 1971	8.5**	--	--	Did not go down			
Mean			7.4	355	.84	26	29	3.6	
SD			2.7	40	.32	14	25	5.2	

* Estimated weight
** Multiple doses

Table 9. Results of immobilization of yearling moose at the Kenai Moose Research Center, Alaska with etorphine (M-99) and diprenorphine (M 50-50).

Animal No.	Sex	Month Year	Total Dose mg	Weight Kg	Dose mg/45 kg	Induction Time min.	Time Immobilized min.	Reversal Time min.
			SATISFACTORY RESPONSE					
44	M	Oct. 1969	5	--	--	8	20	1
Walter	M	Nov. 1970	1.5	300	.23	7	--	--
Walter	M	Nov. 1970	1.5	300	.23	6	1	1
Richard	M	Nov. 1970	3	314	.43	8	2	2
Raquel	F	Nov. 1970	1.5	--	--	6	1	2
Wally	M	Nov. 1972	5	273	.83	14	36	0.5
Wally	M	Nov. 1972	5	273	.83	6	24	1
Wally	M	Dec. 1972	5	298	.76	5	47	1.5
Wally	M	Feb. 1973	6	320	.85	6	44	2.0
Richard	M	Mar. 1971	1.3	--	--	3	2	1
Wally	M	Mar. 1973	6	340*	.80	6	34	0.5
Richard	M	Apr. 1971	1.5	--	--	3	--	--
Wally	M	Apr. 1973	6	340*	.80	6	20	0.5
7	M	Jun. 1970	3	--	--	7.5	6.5	1
Walter	M	Jul. 1971	3.7**	291	.58	6	21	1
Mean			3.6	305	.63	6.5	19.9	1.2
SD			0.5	24	.25	2.5	16.6	0.6
			UNSATISFACTORY RESPONSE					
37	F	Jun. 1970	3	--	--	Did not go down		
Richard	M	Nov. 1970	2**	690	--	32 Forced Down	18	6

* Estimated weight
** Multiple doses

Table 10. Results of immobilization of moose calves at the Kenai Moose Research Center, Alaska, with etorphine (M-99) and diprenorphine (M 50-50) antagonist.

Animal No.	Sex	Month Year	Total Dose mg	Weight Kg	Dose mg/45 kg	Induction Time min.	Time Immobilized min.	Reversal Time min.
205	F	Oct. 1973	3	160*	.86	9	53	1.5
92	F	Nov. 1972	3	166	.82	8	34	1.5
206	M	Nov. 1973	3	148	.92	9	36	1
96	M	Dec. 1972	3	145	.94	10	31	1
Rastus	M	Dec. 1973	3	184	.74	6	28	2
216	F	Dec. 1973	3	170*	.80	4.5	19	2
214	M	Dec. 1973	3	159	.86	9	--	3.5
211	F	Dec. 1973	3	145	.94	6	--	1
97	M	Jan. 1973	3	148*	.92	7	18	1
218	M	Jan. 1974	3	170*	.80	8	--	2
221	F	Jan. 1974	3	160*	.86	15	54	1
223	M	Jan. 1974	3	170*	.80	1.5	10	4
41	F	Feb. 1971	3	--	--	--	--	--
Rastus	M	Feb. 1974	3	209	.65	6.5	48	1
236	F	Feb. 1974	3	160*	.86	6.5	--	--
238	F	Feb. 1974	3	160*	.86	8	21	6
6970	M	Sep. 1970	2	--	--	9	21	1
7070	F	Sep. 1970	2	--	--	--	--	--
7470	F	Sep. 1970	3	--	--	2	25	1
107	M	Sep. 1973	3	135*	1.00	4	23	1
108	M	Sep. 1973	3	135*	1.00	8	28	1
99	M	Sep. 1973	3	160*	.86	6	24	1.5
Mean			2.9	160	0.86	7.2	29.9	1.8
SD			0.3	17	0.09	2.9	12.9	1.3

* Estimated weight

2.1 minutes (Table 7). The mean total "s" yearling dose was 3.6 mg (0.63 mg/45 kg) with a mean induction time of 6.5 minutes and a mean reversal time of 1.2 minutes. The mean total "s" calf dose was 2.9 mg (0.86 mg/45 kg) with a mean induction time of 7.2 minutes and a reversal time of 1.8 minutes.

The dosage reported by Houston (1970) for Shiras moose *(A. a. shirasii)* was 3 to 5 mg total (0.4 to 0.7 mg/45 kg) for yearlings and 1 to 2 mg total (0.4 to 0.7 mg/45 kg) for calves. The total dosage is significantly less for Shiras moose which may be expected as they are in general smaller than Alaskan moose. The dosages at the MRC for adult and calf moose were equivalent on a unit weight basis (0.86 mg/45 kg) and they were higher than reported for Shiras moose adults and calves (0.4 to 0.7 mg/45 kg). The yearling dosages for both Shiras and Alaskan moose were similar on unit weight basis (0.6 to 0.8 mg/45 kg for Shiras and 0.63 mg/45 kg for Alaskan). Alford et al. (1974) reported optimal dosage for moose as 0.98 mg/45 kg of body weight. Dosages from the MRC and from those reported by Houston (1970) were lower than optimum recommended on a unit weight basis. This may in part explain some of the difficulties experienced with some individuals at the MRC (Table 8).

The dosage of 0.84 mg/45 kg body weight for "u" adult moose at the MRC (Table 8) compares favorably to the 0.86 mg/45 kg dosage for "s" adult moose (Table 7). The primary difference in these two groups of moose was that 17 of 26 (65.4%) of "u" classified moose were given multiple doses over a period of time. Only 1 of 43 (2%) "s" classified moose received a multiple dose of etorphine. Twelve of the 17 multiple dosed moose had to be forced down or did not go down (Table 8). The conclusion was that etorphine should be administered in a single adequate dose and that multiple dosing was primarily responsible for creating the unsatisfactory results experienced at the MRC.

The reversal time using diprenorphine for all "s" classified moose was 1.85 minutes. This provided a quick and effective reversal and was one of the primary advantages of this drug combination. There were no consistent differences between sex and age classes on reversal time. Differences were primarily individual and often situational in that disturbance associated with the use of diprenorphine usually resulted in faster reversal response.

Etorphine and diprenorphine use for an immobilizer would be the first choice at present at the MRC if the tissue residue studies were completed and a safe recommended withdrawal period could be recommended. These drugs are licensed by the Bureau of Narcotics and Dangerous Drugs which entails some administrative and supply problems. The other disadvantage is cost. The mean cost to immobilize and reverse an adult moose was $14.00, compared to a few cents with succinylcholine chloride.

CI-744: This unnamed, experimental, multispecies, parenteral, anesthetic agent was used to immobilize 14 Alaskan moose with variable results (Table 11). CI-744 is a 1:1 combination of two ingredients:

Table 11. Results of Immobilization of Alaskan Moose at MRC with CI-744.

Animal No.	Month	Total Dose Mg	Weight Kg	Dose per Kg	Number of Injections	Induction Time Min.	Time Immobilized Min.	Return to Normal Min.
134	March	500	164	3.1	1	1	49	99
63	March	1300	443*	2.9	3	35	18	68
64	April	1000	282	3.5	1	0.5	91	219
65	April	1100	296*	3.7	4	42	87	342
66	April	800	327	2.4	1	4	Animal died from injury	
67	April	1450	300*	4.8	2	20	103	328
43	April	2400	409*	2.9	2	Did not go down		
Wally	April	1130	214	5.3	3	26	15	89
78	June	1200	387*	3.1	2	2	22	104
75	July	1000	296*	3.4	1	Did not go down		
670	July	1000	273*	3.6	1	Did not go down		
R70-8	July	1100	319*	3.4	1	Did not go down		
35	July	2200	443*	4.9	3	35	Had to hold down	
Raquel	August	1600	395	4.0	1	7	46	99

* Estimated weight

tiletamine hydrochloride (CI-634), a central nervous system depressant which produces profound analgesia and cataleptoid anesthesia, and diazepionone (CI-716), a non-phenothiazine derivative tranquilizer.

The uncertainty associated with establishing dosages for Alaskan moose may be responsible for much of the variability. Initially dosages on the conservative side of those recommended for the bovine were used. Problems encountered with this low dosage were confounded by the extremely poor condition of the animals. As the animals' condition improved, dosages were increased and somewhat better response was noted in the animals that went down. A high proportion of animals did not go down; however, some of these may not have received the full dose from the 10 cc "Cap-Chur" syringe. The three animals which did not respond in July were not given supplemental doses since they were "heating up" due to high ambient temperature and stress from trapping.

There were several problems which necessitated terminating use of this drug. The first was the long period of ataxia experienced by animals during recovery. This required spending much time with the animal through the recovery phase. We also had problems in concentrating the drugs sufficiently to incorporate an immobilizing dose in a 10 cc "Cap-Chur" syringe. A renewed attempt to evaluate this drug will be made when the moose are in prime condition and when the volume of drug required can be reduced.

Xylazine: This analgesic, central nervous system depressant and muscle relaxant produced sedation and analgesia in moose with dosages of 2.2 mg/kg body weight. The usefulness of this drug is limited for most moose processing applications at the MRC due to the prolonged period of ataxia experienced during recovery (up to 2 hours). This necessitated assigning individuals to remain with the moose at the trap through this period of time. When multiple trappings of moose were made it was excessively time consuming. This was the only objection we had to using the drug and will use it at the MRC for procedures not limited by time.

Other Immobilizing Drugs: Phencyclidine hydrochloride, propriopromazine hydrochloride and pentobarbital sodium were utilized on moose on a limited basis (LeResche and Davis 1971), but were discontinued due to poor results obtained. With the present selection of available drugs, they will not likely be retested at the MRC.

Trapping

The layout of traps at the MRC was diagrammed by LeResche and Davis (1971). An additional trap was built in the northwest corner of Pen 4 and put into operation in January, 1973. Design for the traps was described by LeResche and Lynch (1973). Nine outside and 11 inside traps are now being used. Their relative success is shown in Tables 12 and 13.

A processed moose was one that was immobilized in the trap. Moose were immediately released if they had been processed within the previous

Table 12. Trap effectiveness by individual trap and pen within the enclosures at the Kenai Moose Research Center, 1969-1974.

Trap Number	No. Trap Nights	No. Moose Processed	No. Moose Released	No. Moose Escaped	No. Malfunctions (moose)	(other)	No. Moose Driven into trap	Trap Success
1E	209	44	27	4	5	4	3	.36
1W	196	18	6	5	4	2	1	.15
1N	218	21	5	--	2	3	--	.12
2S	283	42	20	5	12	6	--	.24
2E	272	29	9	--	11	6	--	.14
CP-2	126	16	7	4	--	3	1	.21
3N	182	15	7	6	11	1	1	.15
3S	222	29	9	2	3	1	--	.18
4SE	227	40	9	4	4	7	1	.23
4S	243	19	8	3	1	3	2	.12
4NW	112	25	14	--	6	1	3	.35
Pen 1	623	83	38	9	11	9	4	.21
Pen 2	681	87	36	9	23	15	1	.20
Pen 3	404	44	16	8	14	2	1	.17
Pen 4	582	84	31	7	11	11	6	.21
All Pens	2290	298	121	33	59	37	12	.20

Table 13. Trap effectiveness by individual trap outside the enclosures at the Kenai Moose Research Center, 1969-1974.

Trap Number	No. Trap Nights	No. Moose Processed	No. Moose Released	No. Moose Escaped	No. Malfunctions (moose)	(other)	No. Moose Driven into trap	Trap Success
10E	289	37	6	5	7	3	--	.17
10S	246	39	9	7	3	7	--	.22
10W	213	12	2	1	--	4	--	.07
10N	195	30	7	8	4	3	--	.23
20N	169	17	4	1	--	--	--	.13
30N	181	15	9	8	1	4	--	.18
40S	253	38	6	20	5	4	1	.25
40E	224	30	10	19	1	2	1	.26
40W	262	22	8	2	2	7	--	.12
All Traps	2032	240	61	71	23	34	2	.18

three to four weeks. Others were released when they did not respond to the drug, became overheated or were calves and processing was not desired. If more than one moose was caught per trap, often one was released. Moose that escaped generally went over the top of the fence after smashing it down or exited between the gate and fence. Escape was most common during the winter from the outside traps when moose, not accustomed to entrapment, stood on approximately one-half meter of hard-packed snow. The fence barrier apparently was not much of a deterrent at this time. A common source of trap malfunction was the trigger string. Monofilament line was tried because of its transparency, but proved too elastic and normally only triggered one gate before breaking. Malfunctions, other than those occurring when moose were present, were largely caused by wind knocking the trigger loose on one gate. On separate occasions a brown (*Ursus arctos*) and a black bear (*Ursus americanus*) triggered traps. Malfunctions occurring during the day that went unnoticed, took away the subsequent trap night, since moose were normally trapped near dawn during their period of greatest activity (LeResche and Lynch, 1973). We were able to drive some moose standing along the fence into a nearby trap by snow machine, truck or afoot. Trap success was calculated by dividing the total number of moose caught by the number of trap nights.

Little difference in overall trapping success was noted for outside and inside traps, although there was much variability between individual traps (Tables 12 and 13). Trap effectiveness in Pen 3 was lower than in the other pens (Table 12). This was likely a function of moose density since Pen 3 had the least moose throughout this report period.

When seasonal influences were considered (Tables 14 and 15), trapping success differences between outside and inside traps were more noticeable. Other than for May, when trapping effort was reduced due to break-up, success was highest during October, November, December and January for outside traps (Table 15). A possible cause was that moose were rutting and migrating to winter areas during this time and were more susceptible to being trapped. Trapping success inside the enclosures was highest during July, August and September possibly due to the enclosed moose attempting to expand their summer range. Trapping success, both inside and outside the pens, was low during February, March and April possibly reflecting the decreased movement associated with moose winter home range. Moose aggregations, as reported by Peek et al. (1974), may additionally influence trap success, particularly of traps outside the MRC enclosures. They reported that summer aggregations were the smallest (low trap success outside) and post-rut the largest (high trap success outside). Undoubtedly many other factors were involved in trap success, but it was observed that some of the movement, aggregation and behavior patterns of moose did correspond to trap success.

An attempt was made to increase trap success during the spring and summer of 1972 by using salt blocks. Salt was placed under the trigger string in most traps and was quite successful in attracting bulls in early summer. One particular bull (#36, Pen 2) defended a salt block and displayed aggressively toward us and our vehicle when approached.

Table 14. Trap effectiveness by month for traps inside the enclosures at the Kenai Moose Research Center, 1969-1974.

Month	No. Trap Nights	No. Moose Processed	No. Moose Released	No. Moose Escaped	No. Malfunctions (moose)	(other)	No. Moose Driven into trap	Trap Success
January	176	17	11	--	2	2	3	.16
February	224	13	11	1	1	3	--	.11
March	184	6	1	--	3	1	1	.04
April	240	7	1	--	4	1	--	.03
May	74	8	3	3	1	--	--	.19
June	217	38	12	3	8	5	--	.24
July	208	58	25	6	10	6	--	.43
August	215	50	26	7	5	5	--	.39
September	185	45	16	7	8	5	--	.37
October	190	26	9	6	13	4	2	.22
November	150	17	1	1	2	--	--	.13
December	231	11	7	1	2	2	3	.08
Total	2294	296	123	35	59	34	9	.20

Table 15. Trap effectiveness by month for traps outside the enclosures at the Kenai Moose Research Center, 1969-1974.

Month	No. Trap Nights	No. Moose Processed	No. Moose Released	No. Moose Escaped	No. Malfunctions (moose)	No. Malfunctions (other)	No. Moose Driven into trap	Trap Success
January	141	21	5	10	4	5	--	.26
February	227	26	3	6	2	3	1	.15
March	107	15	1	--	2	2	--	.15
April	129	11	1	--	--	--	--	.09
May	35	5	3	3	1	2	--	.31
June	132	18	3	4	3	--	--	.19
July	88	13	--	4	1	2	--	.19
August	143	11	--	3	--	3	--	.10
September	273	33	10	6	4	4	--	.18
October	410	47	21	17	3	4	--	.21
November	147	19	3	7	--	--	--	.20
December	186	23	8	8	3	6	1	.21
Total	2018	242	58	68	23	31	2	.18

Two cows and one calf also came to the salt frequently. As the summer progressed, less use was made of the salt blocks. The blocks were removed to reduce influences on physiologic studies, but enough had leached into the soil that some moose still licked the ground in the spring of 1973. No natural salt licks have been located in the vicinity outside the enclosures; however, outside moose were not attracted to salt blocks placed in outside traps.

Aerial Census Evaluation

Aerial-count-census-evaluation study results of 1970 and 1971 were published (LeResche and Rausch 1974). No subsequent attempts to test observer success in aerial composition counts were undertaken due to lack of calf and yearling moose within the enclosures. There was total calf and yearling loss during the winter of 1971-72 and total calf loss in the winter of 1972-73 at the MRC.

Helicopter surveys of known populations of moose made within the MRC enclosures on June 20, 1972, June 18, 1973 and June 17, 1974 are summarized in Table 16. The variability in observational success from year to year probably relates more to leaf emergence than other factors. June is a poor time to survey moose, but the purpose of these surveys was primarily to record calf births and the observational success was recorded secondarily. It was expected, and found, that the more time spent in helicopter surveying at the MRC enclosures the better the percent moose observed. The percent success for time expended does not justify helicopter surveying after leaves have emerged.

Pellet-Count Census Evaluation

A Poisson distribution was tested with the pellet group data from each vegetation type and against the pooled count each year. In all cases, except for the pooled count in 1971, the Poisson distribution fit the observed distribution (Table 17), indicating a random placement of pellet groups within each vegetation type. The mean number of pellet groups per type was then compared by analysis of variance using a $x + 1/2$ transformation of the data. In all four years the hypothesis of no difference among the habitat types was rejected ($a = 0.01$). On this basis, we summed the number of pellet groups per type to obtain a stratified estimate of the total number of groups deposited in the enclosure. In each of the four years this estimate was uniformly higher than the value obtained by pooling the data.

From stratified total winter pellet groups (Table 17) and total moose days (Table 18) pellet groups/moose/day were calculated (Table 19). In winter 1970-71, 3,575 moose days resulted in 72,370 pellet groups for a calculated 20.2 pellet groups/moose/day. In winter 1971-72, 3,082 moose days produced 80,945 pellet groups or 26.3 pellet groups/moose/day. During winter 1972-73, 2,303 moose days produced 64,123 pellet groups or 27.8 pellet groups/moose/day and in winter 1973-74 1,475 moose days produced 42,401 pellet groups or 28.7 pellet groups/moose/day.

Table 16. Helicopter surveys of known populations of moose at the Kenai Moose Research Center, Alaska. 1972-74.

June 20, 1972

Pen No.	Helicopter Time(min)*	Moose Present	Moose Observed	Percent Observed
1	49	12	9	75
2	49	14	11	79
3	49	8	7	88
4	49	13	11	85
Total	196	47	38	81

* Total time only available - divided equally for each pen.

June 18, 1973

Pen No.	Helicopter Time(min)	Moose Present	Moose Observed	Percent Observed
1	43	10	10	100
2	51	7	7	100
3	30	7	6	86
4	114	13	12	92
Total	238	37	35	95

June 17, 1974

Pen No.	Helicopter Time(min)	Moose Present	Moose Observed	Percent Observed
1	26	7	5	71
2	33	12	8	67
3	26	7	5	71
4	76	16	14	88
Total	161	42	32	76

Table 17. Pellet-groups deposited by vegetative type per 17.9m^2 plot, hectare and type with chi-square values for Poisson distribtuion during winters Kenai Moose Research Center, Alaska 1970-74.

Vegetative Type 1970-71	Hectares	Probability of larger X^2 for Poisson Distribution	Pellet Groups Per Plot X	S^2	N	Per Hectare	Type	% of Total
Dense Mature Hardwoods	21.1	0.25	0.45	0.576	20	251.6	5309	7.3
Thin Mature Hardwoods	18.7	0.25	0.68	0.673	19	379.5	7096	9.8
Spruce Birch Regrowth	36.2	0.25	0.33	0.319	24	82.7	2995	4.1
Spruce Regrowth	16.1	0.25	0.20	0.168	20	250.8	4038	5.6
Dense Birch Spruce Regrowth	45.7	0.22	1.28	1.877	25	718.1	32815	45.3
Medium Birch Spruce Regrowth	38.4	0.25	0.73	0.845	26	409.7	15734	21.8
Thin Birch Spruce Regrowth	28.1	0.25	0.28	0.293	25	156.0	4383	6.1
Pooled Total	204.3	0.01	0.58	0.802	159	324.7	66326	-
Stratified Total							72370	100.00
1971-72								
Dense Mature Hardwoods	21.1	0.25	0.30	0.221	20	167.8	3541	4.4
Thin Mature Hardwoods	18.7	0.25	0.75	0.145	20	418.6	7827	9.7
Spruce Birch Regrowth	36.2	0.25	0.50	0.435	24	125.3	4537	5.6
Spruce Regrowth	16.1	0.25	0.20	0.274	20	250.8	4038	5.0
Dense Birch Spruce Regrowth	45.7	0.25	1.20	1.000	25	673.2	30764	38.0
Medium Birch Spruce Regrowth	38.4	0.25	0.88	0.586	26	493.9	18967	23.4
Thin Birch Spruce REgrowth	28.1	0.25	0.72	0.543	25	401.1	11271	13.9
Pooled Total	204.3	o.25	0.68	0.686	160	380.7	77767	-
Stratified Total							80945	100.0

Table 17. Pellet-groups deposited by vegetative type per 17.9m^2 plot, hectare and type with chi-square values for Poisson distribtuion during winters Kenai Moose Research Center, Alaska 1970-74.

Vegetative Type 1972-73	Hectares	Probability of larger X^2 for Poisson Distribution	Pellet Groups Per Plot X	S^2	N	Per Hectare	Type	% of Total
Dense Mature Hardwoods	21.1	0.25	0.30	0.221	20	167.8	3541	5.5
Thin Mature Hardwoods	18.7	0.25	0.70	1.063	20	390.6	7305	11.4
Spruce Birch Regrowth	36.2	0.25	0.17	0.145	24	42.6	1543	2.4
Spruce Regrowth	16.1	0.25	0.20	0.274	20	250.8	4038	6.3
Dense Birch-Spruce Regrowth	45.7	0.14	0.92	0.910	25	516.1	23586	36.8
Medium Birch-Spruce Regrowth	38.4	0.25	0.77	0.825	26	432.2	16596	25.9
Thin Birch Spruce Regrowth	28.1	0.25	0.48	0.343	25	267.4	7514	11.7
Pooled Total	204.3	0.25	0.52	0.603	160	291.1	59472	-
Stratified Total							64123	100.0
1973-74								
Dense Mature Hardwoods	21.1	0.25	0.35	0.555	20	196.2	4139	9.8
Thin Mature Hardwoods	18.7	0.25	0.20	0.168	20	111.6	2087	4.9
Spruce Birch Regrowth	36.2	0.25	0.13	0.114	24	32.6	1180	2.8
Spruce Regrowth	16.1		0	0	20	0	0	0.0
Dense Birch-Spruce Regrowth	45.7	0.25	0.68	0.727	25	381.5	17433	41.1
Medium Birch-Spruce Regrowth	38.4	0.25	0.35	0.395	26	196.4	7543	17.8
Thin Birch-Spruce Regrowth	28.1	0.25	0.64	0.407	25	356.5	10019	23.6
Pooled Total	204.3	0.35	0.392	160	195.9	40018	-	
Stratified Total							42401	100.0

Table 18 Moose days at Kenai Moose Research Center, Alaska in Pen 1 for Winters 1970 to 1974*

Moose Number	Winter 1970-71	Winter 1971-72	Winter 1972-73	Winter 1973-74
3	210	210	196	---
Calf of 3	135**	61**	---	---
6	210	135	---	---
Calf of 6	---	61**	---	---
670	210	210	196	---
10	210	210	196	191
Calf of 10	135**	61**	61**	191
35	210	210	196	191
40	210	210	166	---
Calf of 40	135**	61**	---	---
41	115	---	---	---
4170	115	---	---	---
43	210	210	97	191
53	210	210	---	---
55	210	---	---	---
58	210	210	196	191
61	210	210	---	---
6171A	---	61**	---	---
6171B	---	61**	---	---
64	210	210	196	---
65	---	---	67	---
69	210	210	196	191
R70-8	210	210	196	191
Calf of R70-8	---	61**	---	138**
76	---	---	196	---
Calf of 76	---	---	112**	---
93	---	---	14	---
96	---	---	22	---
TOTAL	3575	3082	2303	1475

* Based on 210 day pellet-forming period (November 1 to June 1)
** Estimated - Date of death unknown.

Table 19. Pooled and stratified total pellet-groups in Pen 1, Kenai Moose Research Center, Alaska with calculated pellet-groups/moose/day and calculated and actual moose numbers during winters 1970–74.

Winter	% Pen in Plots	Total Pellet-groups Pooled	Total Pellet-groups Stratified	Moose Days	Pellet-groups per moose/day	Pellet group Days	Moose Numbers Calculated[2]	Moose Numbers Actual
1970–71	0.139	66326	72370	3575	20.2	210	32.2	18.0
1971–72	0.140	77767	80945	3082	26.3	210	36.0	14.7
1972–73	0.140	59472	64123	2303	27.8	196	30.6	11.8
1973–74	0.140	40018	42401	1475	28.7	191	20.7	7.7

1 Based on 210-day pellet-forming winter period (November 1 to June 1)

2 Based on 10.7 pellet-groups/moose/day (DesMueles 1968).

Several investigators have reported pellet groups/day for deer; Smith (1964) reported 13.2 groups/day, Rogers et al. (1958) reported 15.2 groups/day, Rasmussen and Doman (1943) found 12.7 groups/day and Eberhardt and Van Etten (1956) reported 12.7 groups/day. Neff et al. (1965) reported 12.5 pellet groups/day for elk (*Cervus canadensis*). Because our calculated moose daily winter defecation rates of 20.2, 26.3, 27.8 and 28.7 were considerably higher than those reported for other ungulates, we were concerned that the use of pellet group sampling to estimate moose daily defecation rate and thereby moose numbers under the conditions herein described was questionable. As an additional check on the procedure we utilized DesMeules' (1968) observed 10.7 pellet groups/moose/day and the stratified total pellet groups (Table 17) with pellet group days (Table 19) to calculate the number of moose in Pen 1. For the winter of 1970-71, with 210 pellet group days, the number of moose was calculated to be 32.2 when the actual mean number of moose was 18.0. For the winter of 1971-72 the calculated moose number was 36.0 and the actual mean moose number for this 210 pellet group day period was 14.7. During the 1972-73 pellet group day period the calculated moose number was 30.6 and the actual mean moose number was 11.8. During the 1973-74 pellet group day period the calculated moose number was 20.7 and the actual mean moose number was 7.7. The calculated figures overestimated moose numbers each year by factors of 1.8 to 2.7.

If we accept the 10.7 daily defecation rate for moose, or rates from other ungulates, we would conclude that winter pellet group counts were not valid estimators of moose numbers at the MRC and utilization of this census technique for moose in general may be questionable. If we accept that the sampling was valid and that pellet group sampling can be utilized to estimate moose numbers, our calculated defecation rates were valid. We will attempt to establish winter daily defecation rates for MRC moose by direct observation to help resolve this problem.

The separation of winter 1971-72 and 1972-73 pellet groups was apparently successful, as indicated by the calculated pellet groups/moose/day of 26.3 and 27.8, respectively. Any great difference in these figures would have indicated that our criteria for separation were not valid. Aging summer fecal deposits resulted in a total of 11 deposits in 1971 and 22 in 1972 which we believed invalidated our summer aging technique since there were more moose in Pen 1 the summer of 1971 than 1972. Apparently, the older summer fecal deposits had deteriorated.

Winter habitat selection by moose, as indicated by pellet groups per vegetative type (Table 17), demonstrated an affinity for birch regrowth (combined dense, medium and thin birch-spruce regrowth) areas. During all four winters 73.2 to 82.5 percent of pellet groups were in these areas. Spruce regrowth areas (combined spruce-birch regrowth and spruce regrowth) for the four winters contained 2.8 to 10.6 percent of the pellet groups. Mature hardwood areas (combined dense and thin mature hardwoods) had from 14.1 to 17.1 percent of the pellet groups each year.

Summer habitat selection by moose, as indicated by fecal deposits per vegetative type, was perhaps not useful since aging of summer deposits was not valid and spruce-*Ledum*, grass, sedge and water areas, which were observed to receive substantial summer use, were not sampled. Nevertheless, it should be noted that in all four years no summer fecal deposits were counted in thin mature hardwoods and only five were counted in dense mature hardwoods.

Neff (1968:612) stated: "A major problem requiring future research attention concerns the use of pellet group distribution pattern as index to habitat preferences." Anderson et al. (1972) could find no significant correlations between indices of mule deer numbers and mean yield or utilization of selected deer browse types. We believe the winter habitat selection by moose at the MRC, as reflected by pellet group distribution, corresponds to observed and expected use. LeResche and Davis (1973) reported that tame moose on normal range at the MRC consumed 72 percent birch stems on normal range in February - May and 21 percent of the remaining material was lowbush cranberry (*Vaccinium vitis-idaea*). Birch-spruce regrowth (73.2 to 82.5 percent of pellet groups) provided the dominant winter browsing area. Thin mature hardwood areas contain the greatest proportion of ground cover lowbush cranberry (Oldemeyer and Seemel 1974). The corresponding substantial moose use of these areas, reflected by pellet group distribution, was likely related to their use and importance to moose. However, an undetermined proportion of hardwood use by moose in winter may relate to protection, resting and relief from snow and may partially account for pellet group distribution. The relative lack of use of hardwoods by moose in summer, based on pellet group distribution, was reasonable because LeResche and Davis (1973) reported that lowbush cranberry at the MRC was taken in trace amounts during the summer. With foliage present in birch areas, protection and resting areas are more numerous in regrowth and mature timber was not necessarily required. Spruce regrowth areas received the least moose use, based on pellet group distribution, and this was expected since moose do not browse spruce and these areas contain low densities of birch. The percent of use found (2.8 to 10.6) may relate to use of these areas for protection in addition to the presence of some browse.

Telemetric Tracking

The 30 mhz radio transmitters utilized at the MRC for behavioral studies (LeResche and Davis 1971, and Johnson et al. 1973) functioned with no major failures; however some transmitters worked better than others. Two multi-frequency receivers were utilized with the major problem being related to antenna wire connections.

Although no major problems were associated with the transmitters and receivers, many hours were required to locate radio-collared moose with uni-directional receivers. Considering the moose were within a 2.59 km^2 area, the application of uni-directional receivers from the ground was limited.

Biotelemetry

No biotelemetry equipment was utilized during this report period;

however, the application and use of temperature and heart rate equipment were investigated and a proposal for studies utilizing this equipment at the MRC was prepared.

Rumen Sampling

The one-step rumen fistulation procedure was unsuccessful, in one completed attempt, due to the flanges from the fistula plug assembly causing tissue necrosis and rejection of the apparatus in approximately 10 days. The fistula itself healed satisfactorily, but the aperture closed completely about 18 months after surgery (LeResche et al. 1973).

A procedure to obtain rumen contents from elk and deer using a trocar (Follis and Spillett 1972) was used on a four-year-old male moose at the MRC on June 30, 1972. The technique is easily accomplished and, with the moist rumen contents in June, it was easy to obtain a sample without the mechanical fingers. This particular animal experienced difficulties while immobilized and rolled on his side after being trocared and some leakage of rumen contents into the abdominal cavity was noted. The animal recovered from immobilization and was released back into Pen 2. The moose was seen alive on July 18, but was found dead on August 3. The condition of the carcass did not permit an autopsy to determine cause of death, but it is possible that the moose developed peritonitis from rumen contents spilled into the abdominal cavity. Therefore, it is important, in summer, when rumen contents are more fluid, to retain the animal in sternal recumbency or preferably in a standing position for the trocar procedure. Further testing of this procedure was discouraged by this experience, and the stomach tube and pump method was adopted.

A three meter by 1.3 cm (inside diameter) plastic stomach tube and a standard two-way veterinary stomach pump were used to obtain rumen liquor for *in vitro* digestion trials. During winter, it was difficult to pump the dry rumen contents with this equipment. Much time was required in the attempts and with prolonged immobilization (etorphine) two moose died. Both moose were in extremely poor condition. Rumen liquor was pumped from one of the moose prior to death after water was pumped into the rumen to moisten the contents. A moose was immobilized during late summer in another attempt to obtain rumen liquor via stomach tube, but the moose died due to overheating resulting from difficulties with the procedure.

The undesirable side effects associated with this procedure have discouraged using it. In reviewing our failures we recommend that attempts with this procedure should; utilize a portable suction pump in place of hand pump, incorporate an effective tranquilizer with the immobilizing drug (especially during summer) and be attempted only on animals in good condition.

Marking Techniques

Collars:

The major problem with the collars initially used was that they did not allow long range identification of the moose as an individual.

Numbers on the rope collars were too small to read except under ideal conditions on the ground. The collar itself did not identify the moose as a particular individual. Solid color canvas-web collars identified the moose only to tagging site. The "magic marker" numbers then placed on solid color collars were too small to read easily and faded out rapidly.

Pendants, when hung parallel to the longitudinal axis of a moose, were readable from aircraft more than 90 percent of the time, upon repeated passes. Pendants hung perpendicular to the axis could be read less than 30 percent of the time. Much time, and therefore money, was consumed making repeated passes to observe the entire letter/number sequence. In some cases the pendants broke partially or completely off, and were no longer legible.

The stripe combination collars were individually identifiable readily from aircraft and remained so for considerable lengths of time, but observers were not always able to correctly discern all color combinations.

The use of quadracolor collars was also hampered by the observers' ability to discern colors, especially with the yellow and/or pink color combinations. Repeated passes by aircraft were sometimes necessary to record all the colors.

The latest type of collar being tried (15.3 cm wide with 12.7 cm numerals) appeared to be the most readable. Normally only one pass of the aircraft was necessary to read the number. Collars with light backgrounds were visible on moose for several kilometers. They have not been used long enough to discern possible problems. Perhaps light numbers on a dark background may not be legible as they darken with age.

No attempt has been made to determine the retention rate of collars. This would be difficult to calculate for free-ranging moose and those within the MRC enclosures were collared at varying ages (i.e. sizes) and collar loss may be more frequent within the enclosures.

Eartags:

The metal Hasco eartag with colored Saflag material has proved to be the mose effective and useful way to ear-mark moose. Some necrosis of tissue surrounding the ear piercing has resulted, but the occurrence is minor. The metal tag normally was retained until removed or torn out on brush. The Saflag material deteriorates with age and must be replaced on enclosed moose about every two years. Free-ranging moose gradually lose this identification.

Large, black Ritchey eartags were ideal for legibility and retention with no tissue necrosis, but observability was restricted to ground viewing at close range.

Both the Jumbo and Goliath Rototags proved ineffective. Retention rate was good and tissue necrosis negligible, but both were difficult to read except under ideal conditions. Some breaking or cracking was experienced at installation.

Freeze-branding:

Freeze-branding efforts proved unsuccessful on moose at the MRC. In November 1970 the 60-second brands (acetone/dry-ice) created scar tissue and a standard burn-brand was covered by hair in summer. Twenty- and 40-second brands were not evident after hair regrowth. No unpigmented hair emerged. The March 1973, 20-second spray-on "brand" did not produce adverse effects but no brand resulted.

The June 1973 freeze-branding attempt produced excessive scarring initially on brand areas 1, 2 and 3. After 1 year no usable brand resulted (Table 20), but a few white hairs were noted in areas 1 and 2. Other areas had no unpigmented hair emerge or had tissue scaring.

Weighing

The following paragraphs in this section were taken from the manuscript entitled "A winch-tripod device for weighing moose" which was submitted for publication.

Many devices have been used with varying degrees of success for weighing large mammals in the field. Doutt (1940) employed a tripod with 3.8-liter (1-gallon) water containers as counter-weights on a lever arm and an 11.6-kg (25-pound) capacity spring scale for weighing various big game animals. A field expedient method used by Bergerud et al. (1964) for weighing caribou (*Rangifer tarandus*) and moose (*Alces alces*) consisted of a tripod and balancing beam of spruce or fir poles with a man counter-balancing the animal and a distance-man's weight formula to derive the animal's weight. Various other combinations of tripods and support beams with block and tackle, chain hoist or hand winches used to raise the animal have been tried (Talbot and Talbot 1962, Smith and Ledger 1965, Blood et al. 1967 and Timmerman 1972). Greer and Howe (1964) used a boom on a hoisting truck for weighing elk (*Cervus canadensis*).

A convenient, reliable weighing device was needed at the Kenai Moose Research Center (MRC) where year-round trapping and handling of moose were conducted, using the trap and procedure described by LeResche and Lynch (1973). Whole weights of moose are used in the MRC research program to measure seasonal weight fluctuations of individual moose, determine age at which body growth ceases and appraise population vigor, through age-weight correlations. Methods used initially at the MRC, including two types of booms on a hoisting truck and a tripod with a chain hoist, proved undependable and time consuming.

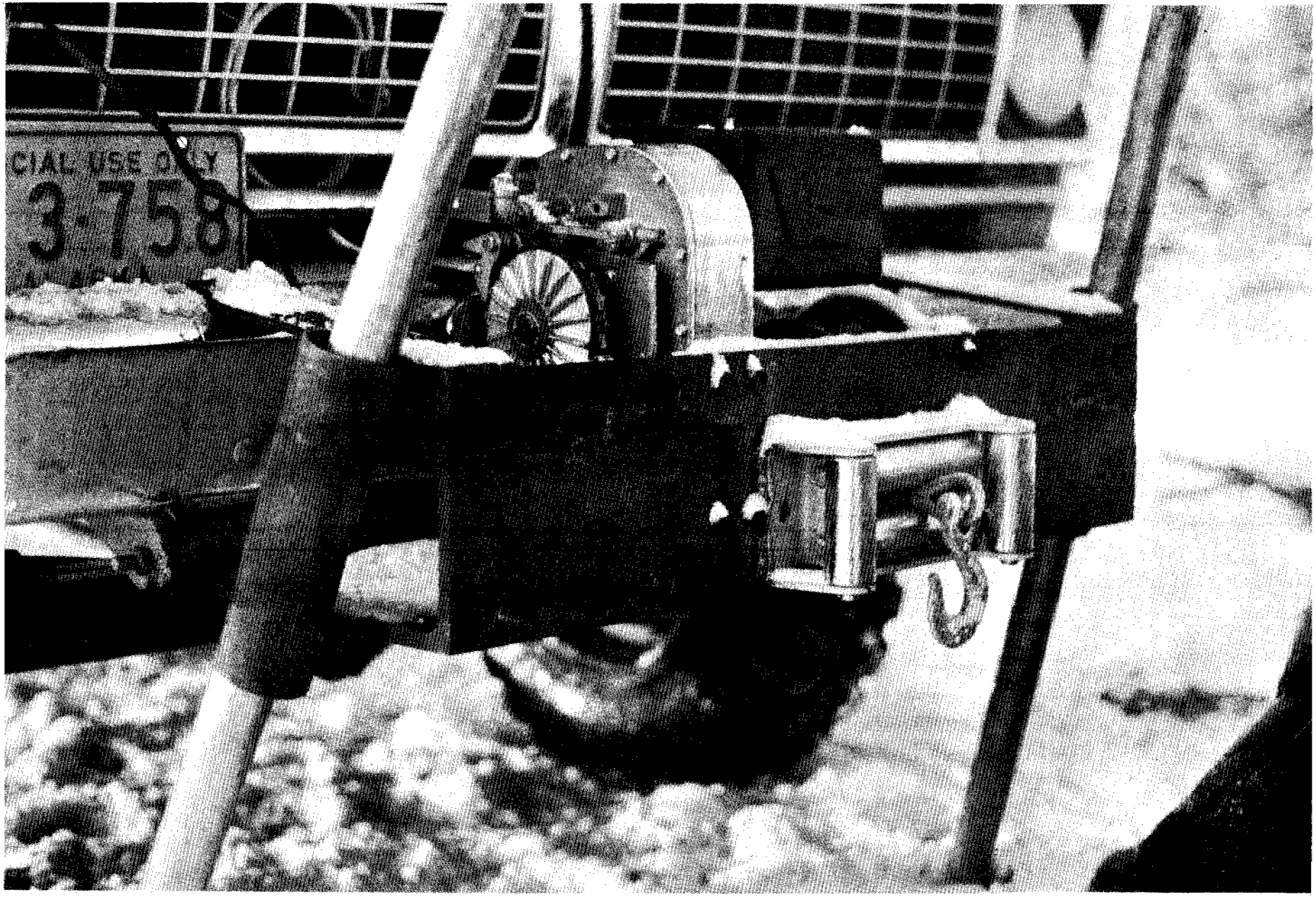
The presently used system consists of an electric winch/hoist (Warn Industries Inc., Seattle, WA) mounted on the front of a pickup truck with bracket, designed to hold two legs of a tripod (Fig. 4). The tripod is made of 5.1 cm aluminum pipe 3.7 mm long and a snatch block (McKissich Products Corp., Tulsa, OK) is fastened to a clevis at the apex of the tripod. Wide shoes that slip over the bottoms of the tripod legs prevent sinking into soft ground.

Table 20. Freeze-branding trial utilizing bottled Freon gas on June 4, 1973.

Brand Area	Type of Gas	Time (Sec.)	Type of Thaw	Results[1]
1	Freon 12	30	Delayed	Few White Hairs
2	Freon 12	45	Quick	Few White Hairs
3	Freon 22	15	Quick	None
4	Freon 22	30	Quick	Scar Tissue
5	Freon 22	5	None	None
6	Freon 22	10	None	None

1 - Observed on 16 June 1974

Fig. 4. Winch bracket holding two legs of tripod.



The weighing procedure consists of slinging the immobilized moose with 1.6 cm rope as described by Frank (1964), driving into the trap to the animal, setting up the tripod, cable and 907 kg capacity scale (John Chatillon and Sons, Kew Gardens, NY) and hoisting the animal (Fig. 5). This entire process can be completed in four minutes or less.

We were able to weigh more moose in the later stages of recumbancy due to the short time period required for weighing. Using earlier, slower methods fewer moose were weighed due to the undesirable aspects of administering additional drugs.

RECOMMENDATIONS

1. Efforts should continue in testing and evaluating new immobilizing drugs for moose as they become available.

2. Succinycholine chloride should be the immobilizing drug used on free-ranging moose and etorphine with diprenorphine are recommended for short procedure immobilization of captive moose or moose which won't be consumed. For long procedure immobilization of moose xylazine is recommended.

3. Testing of observer accuracy and precision in aerial composition counts should be done at the MRC when the moose composition within the enclosures warrants it.

4. Pellet group counts as a censusing technique may not be relied upon for Alaska moose in habitat similar to that at the MRC at present. Studies to determine the daily winter defecation rate at the MRC by observation are needed.

5. Pellet group counts may provide useful information on habitat selection by moose and should be utilized where this information is needed.

6. Telemetric tracking of moose with uni-directional receivers on ground requires much time and should not be incorporated into study plans where time is a factor or many moose must be tracked.

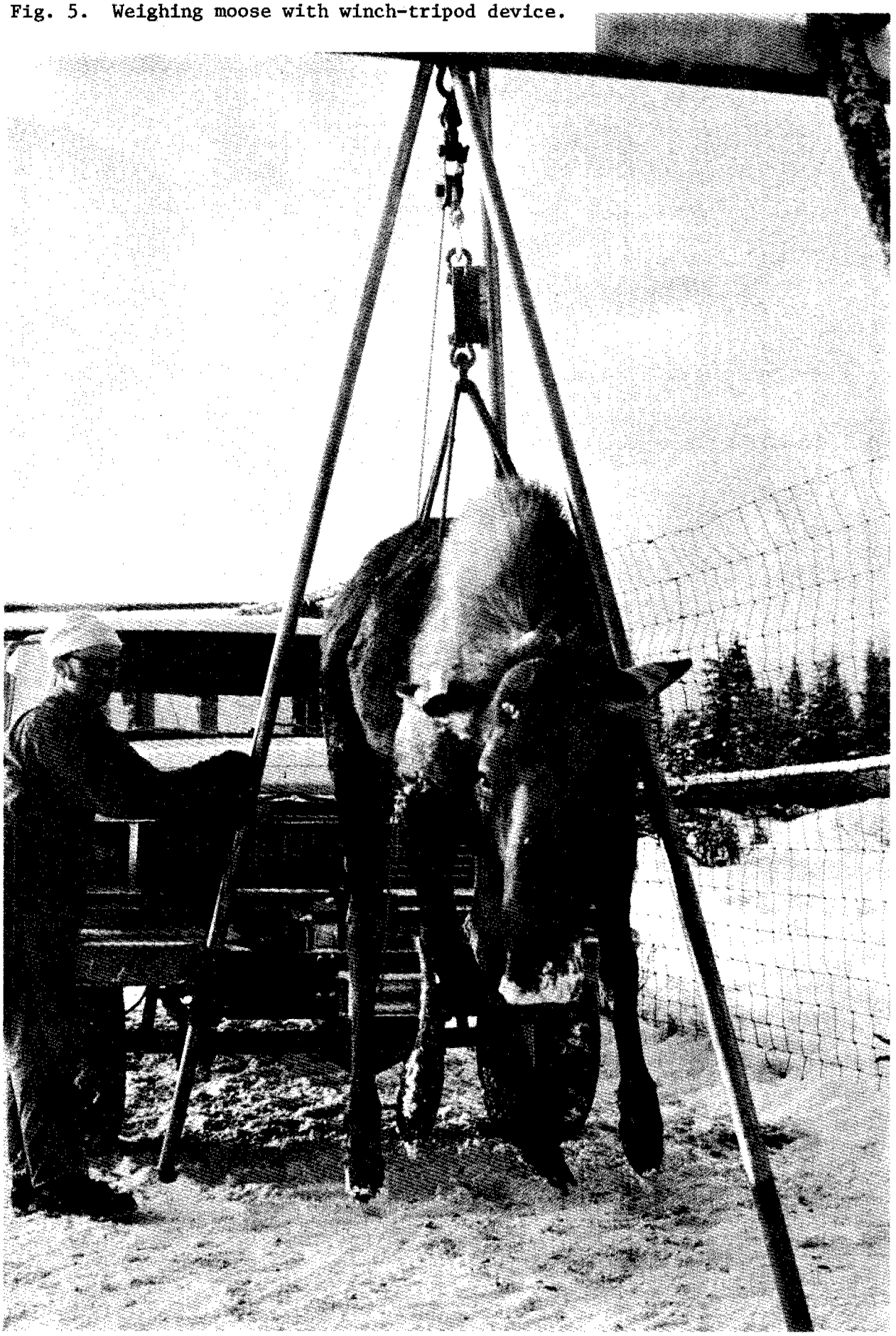
7. Biotelemetry investigations should be pursued based upon work in other fields and the availability of equipment and expertise.

8. Investigations should continue to develop a suitable rumen sampling procedure for moose.

9. Investigations should continue in testing new materials potentially useful for marking moose.

10. The development and testing of new techniques developed in other areas of research should be continually evaluated for their potential application to moose management.

Fig. 5. Weighing moose with winch-tripod device.



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