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EVALUATION AND TESTING OF TECHNIQUES FOR MOOSE MANAGEMENT

by
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Projects W-22-1, W-22-2, W-22-3, W-22-4, W-22-5
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FINAL REPORT

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SUMMARY

The principal immobilizing drug tested on moose was carfentanil (Wildnil, Wildlife Laboratories, Ft. Collins, Co.) and the antagonists used were diprenorphine (M50-50, Lemmon Co., Sellersville, Pa.) and naloxone hydrochloride (Narcan, Endo Pharmaceuticals, Manati, P.R.). Carfentanil dosage varied, according to season and physical condition of moose, from 3 to 6 mg/adult moose. Ninety percent of induction times ranged between 4 and 6 min ($\underline{n}$ = 213). Problems occurred with narcotic recycling or "renarcotization" and some mortality was experienced. To compensate for the renarcotization, higher dosages of diprenorphine were used (10 mg diprenorphine/each mg carfentanil). This appeared to give better initial response, but latent effects were evident, possibly due to the respiratory depression experienced with higher dosages of diprenorphine. Naloxone was then tested as an antagonist at dosages of 90 mg/each mg carfentanil. Several field projects were conducted using naloxone at this rate; problems diminished but were not eliminated. It appeared that moose in a poor physiologic state did not respond as well following the antagonist injection. Five of 87 moose died within 48 hours of capture. Three of the moose that succumbed were in very poor condition. In spite of problems encountered, carfentanil appears to be the present drug of choice for immobilizing moose. The present need for an improved system centers on the availability of an antagonist for carfentanil--one with a longer half-life. The characteristics of carfentanil that make it a preferred product are primarily related to its concentration. It is apparent, however, that an ideal immobilizing system for moose is not yet available for field application. Various new products that may be improvements are discussed in this report.

Ear tag transmitters were tested on moose calves during a calf mortality study; the tags were not found to be useful in that application and their use was discontinued. As a replacement for the ear tag transmitters we developed an expandable neck collar made from Ace bandage material. This method worked very well and we consider it the present best choice of transmitter attachment for moose calf mortality studies.

Late-breeding experiments involving tame moose were conducted at the MRC. All cows were bred after 15 October and all conceived, but productivity was varied and followed no pattern. The possibilities for future work are outlined and discussed.

The MRC has long been utilized for testing new techniques applicable to moose management. For example, snow-monitoring data are reviewed in this report and the development of the MRC moose ration is reported here as well. The MRC facility has also proved useful for retaining wolves and for testing the effects of drugs on louse-infested animals. We feel the facility has the potential for more extensive involvement with other species in addition to moose.

CONTENTS

BACKGROUND

The Moose Research Center (MRC), with known numbers of confined animals, and facilities designed for research, provides unique conditions for developing and testing techniques applicable to moose (*Alces alces*) management (Fig. 1). Developments in many fields have provided information, drugs, equipment, and procedures potentially applicable to moose management. These developments have determined the thrust of activity for this study, which has been continually maintained and functional since July 1969. Two previous final reports under this job description have been prepared; one in 1974, which covered activities from 1969 to 1974 (Franzmann et al. 1974) and one in 1982 covering the period from 1974 to 1981 (Franzmann and Schwartz 1982). Subject areas for testing and evaluation under this project since 1982 include: immobilization with drugs; reversing immobilization with drugs; use of adjunct drugs during immobilization; development of calf mortality transmitters (ear and neck collars); late-breeding studies; evaluations of snow pillow[1] and snow plots; and refinement of the MRC moose ration. Project progress reports have presented these techniques and developments (Franzmann et al. 1983, 1984a; Schwartz et al. 1983, 1985, 1986. In addition, several publications have come from these investigations (Franzmann 1982, 1985; Franzmann and Lance, in press; Franzmann et al. 1982, 1984b, 1984d; Schwartz et al. 1985b. Abstracts of these papers appear as Appendices A through G. This final report provides a summary of these studies.

Drug Testing

After the 1982 Final Report on Developing and Testing New Techniques for Moose Management (Franzmann and Schwartz 1982), we began testing an experimental immobilizing drug called carfentanil, provided by Janssen Pharmaceutica, Beerse, Belgium. Testing began at the MRC in winter 1982-83 and was followed by field testing in spring 1983 on the Alaska Peninsula and in spring 1984 in the Nelchina basin (Franzmann et al. 1984c). Testing continued until June 1986 on carfentanil, which in the interim became commercially available (Wildnil, Wildlife Laboratories, Fort Collins, Co.). We also tested the use of the carfentanil antagonists diprenorphine (M50-50, Lemmon Co., Sellersburg, Pa.) and naloxone (Wildlife Laboratories, Fort Collins, Co.). The criteria used to evaluate immobilizing drugs were (Franzmann 1982):

(1) Rapid absorption and action
(2) Concentrated form--small quantity for injection
(3) Wide range of tolerance for animals
(4) Safe for handler
(5) Reversible
(6) No side effects
(7) Effective anesthesia level
(8) Not subject to Dangerous Drug licensing
(9) Cleared for use on animals used for food
(10) Low cost.

Xylazine hydrochloride (Rompun, Bayvet Div., Miles Laboratories, Shawnee, Ks.) has long been recognized as a useful immobilizing drug and synergist to other immobilizing drugs (Haigh 1982). Its application as an immobilizing drug has been limited because there has been no antagonist or reversing agent available. Recent reports, however, indicate that yohimbine hydrochloride (Antagonil, Wildlife Laboratories, Fort Collins, Co.) and 4-aminopyridine (Sigma Chemical Co., St. Louis Mo.)

[1]An air-filled pillow that measures the weight of snow falling on it.

will reverse the effects of xylazine. We began testing yohimbine on moose. We also summarized body temperatures, heart rates, and respiratory rates of immobilized moose and compared them with values from free-standing moose (Franzmann et al. 1984b).

Telemetry

Calf mortality studies were done on the Kenai Peninsula during spring of 1982 and 1983 (Franzmann et al. 1984c, Franzmann and Schwartz, in press). Similar studies in 1977 and 1978 indicated that improvements in the method of fastening transmitters to newborn calves were needed (Franzmann and Schwartz 1979, Franzmann et al. 1980). We tested ear tag transmitters and an expandable neck collar made from Ace bandage material (Schwartz et al. 1983).

Late Breeding

Late breeding experiments were conducted at the MRC using Pen 3, from which all bulls were removed and a late introduction (23 October) of a mature bull was accomplished (Schwartz and Franzmann 1981). Late breeding and conception did occur; a calf was produced in early July. However, we determined that fixed-wing (Super Cub) overflights of the pen were not adequate to detect all calving events in Pen 3 because the vegetative overstory was too dense. Another option available to us was to use our hand-raised moose when they became sexually mature because these moose could be more easily monitored. We determined in 1980 that both male and female yearling moose could successfully breed as yearlings (Schwartz et al. 1982). In fall 1982, we kept the hand-raised male and female moose separated until 15 October.

Snow Monitoring

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

Moose Ration

The need for a formulated ration to maintain moose over long periods of confinement for nutritional studies has been previously outlined, and such a ration has been developed at the MRC (Schwartz et al. 1980). We have continued to improve on the ration and have reported on those findings (Schwartz et al. 1985).

OBJECTIVE

To test and evaluate techniques and equipment that are potentially useful for management of moose.

PROCEDURES

Immobilizing, and Adjunct Drugs

Drugs useful for capturing moose were tested on moose at the MRC and in the field to determine induction time, tolerance range, reversibility, side effects, and general effectiveness. Drugs tested included carfentanil (Wildnil), diprenorphine (M50-50), naloxone hydrochloride, xylazine (Rompun), and yohimbine (Antagonil). In most instances, the drugs were administered with Cap-Chur equipment (Palmer Chemical Co., Douglasville, Ga.).

Telemetry

Ear tag radio transmitters weighing 50 g and equipped with a 27 cm antenna (Telonics, Mesa, Az.) were purchased for calf mortality studies. The transmitters were fastened to the ear with 2 plastic flange fasteners. The transmitter was designed to conform to the shape of a moose calf's ear. The pulse was adjusted to provide 6-month battery life which was adequate for the requirements of the study.

We also tested an expandable neck collar on moose calves during the calf mortality studies. This collar was made from Ace bandage material which is expandable and generally used for leg wraps. The transmitter and antenna (Telonics, Mesa, Az.) were placed between layers of Ace bandage material and sewn with cotton thread. The collars were made to fit snugly on the calf's neck without expanding.

Late Breeding

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

Snow Monitoring

Snow plots within the MRC enclosures were established in 1970 (LeResche and Davis 1971), one each in the following habitat types: dense hardwoods, thin hardwoods, sedge meadow, spruce regrowth, birch (Betula papyrifera), spruce (Picea mariana) regrowth (thin), birch-spruce regrowth (dense), and spruce-ledum (Ledum spp.). In November 1976, a plot was added to the mechanically rehabilitated area in the south end of Pen 1. A snow pillow was installed in Pen 1 during summer 1981 in conjunction with the U. S. Department of Agriculture, Soil Conservation Service. In 1983, a snow transect and precipitation gauge were placed adjacent to the snow pillow.

Moose Ration

Procedures for developing a formulated ration for captive moose have been outlined by Schwartz et al. (1980).

FINDINGS

Immobilizing, and Adjunct Drugs

Carfentanil (Wildnil) has been the primary immobilizing drug tested at the MRC since the final report on techniques in 1982 (Franzmann and Schwartz 1982). Our experiences with carfentanil immobilization through March 1984 were reported in Franzmann et al. (1984d) (Appendix A). Since March 1984, 24 moose at the MRC have been immobilized using carfentanil as have 87 free-ranging moose. Our experiences and conclusions are summarized in a paper entitled "Chemical Immobilization of Wildlife: Recent Advances," which was prepared for the International Wildlife Management Symposium: Translocation of Wild Animals (Appendix B). This paper also updates our experiences with the other new drugs applicable to animal capture tested at the MRC and elsewhere. We reported baseline body temperatures, heart rates, and respiratory rates for moose at the MRC when immobilized and free-standing (Franzmann et al. 1984b) (Appendix C).

Telemetry

Ear tag transmitters were applied to 3 moose in spring 1982. Problems developed immediately due to the difficulty associated with the fasteners for the ear. The holes were readily punched in the calf's ear and the fasteners inserted, but completion of the fastening process required forcing a round plastic disc over a plastic rod which was expanded on the end. This operation required more time than allowable for handling newborn calves (Franzmann and Schwartz 1979, Ballard et al. 1979). The weight of the ear tag transmitters was too great for the ear to support and, consequently, the ear was pulled down. After applying 3 of these transmitters, it was obvious that the procedure was not desirable and we abandoned the technique.

We used the remaining ear tag transmitters in neck collars made from Ace bandage material (Franzmann et al. 1984c). The Ace bandage neck collars for moose calves worked satisfactorily in that they expanded the desired amount as the neck enlarged with time. Initially, when we built these expandable collars, we experienced a problem with transmitter retention in the Ace bandage material. If a double layer of material was not used, the transmitter would wear through and drop from the collar. In 1983, we had 7 transmitters fall from the collar for this reason. Fortunately, this did not begin to occur until August, which is past the peak calf mortality period (Franzmann et al. 1984c). This problem can be avoided by stronger support around the transmitter as it is sewn in, and by using transmitters with smooth edges. We believe the Ace bandage neck collar is the best of the many devices we have tried to place on moose calves for detection of causes of post-natal mortality.

Late Breeding

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

Jezebel also had twin calves, but 1 calf was mummified and weighed only 5 kg. The other calf appeared healthy and weighed 13 kg. Trixie, Lucy, and Oly all had single calves born in mid-June. All calves were healthy and weighed 14, 19, and

15 kg, respectively. Trixie's calf died from a *Clostridium*-type infection that entered via the umbilicus. In general, late breeding of the tame moose in fall 1982 resulted in all animals reproducing, but with somewhat varying results. The 3 single calves born between 15 and 17 June can be considered the result of late breeding (born after normal peak of calving in late May, early June). Jezebel's calving (twins on 7 June) may not reflect late breeding as much as shortened gestation associated with twinning. There is very little evidence in wild ungulates to demonstrate that the gestation period for twin calves is shortened, but this phenomenon has been recognized in the domestic animal literature for many years (Craig 1912).

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

Snow Monitoring

A summary of snow plot data from the MRC for winters 1970-71 through 1982-83 has been provided by Franzmann et al. (1984*a*). Data from winters 1983-84 through 1985-86 are listed in Table 3. The winters of 1984-85 and 1985-86 were both characterized by lack of significant snow cover throughout the winter until mid- to late March.

Moose Ration

Formulation of the MRC moose ration was first described in a preliminary form (Schwartz et al. 1980). The formulation for the modified and improved ration was recently described by Schwartz et al. (1985) (Appendix D).

RECOMMENDATIONS

1. Efforts should continue in testing and evaluating new immobilizing, adjunct, and reversing drugs for moose.

2. Late breeding experiments should be continued.

3. Studies delineating the length of estrus, periods of estrus, and breeding cycle should be done in association with late-breeding experiments while adult tame animals are available.

4. Monitoring of snow plots should continue at the MRC because the value of these data will increase with time.

5. The MRC moose ration has proven useful and adequate, but we must continue to monitor moose that are solely on the diet; particularly those individuals that have been on it for several years.

6. The testing of new techniques developed in other areas of research should continue to be evaluated at the MRC for their potential application to moose management.

LITERATURE CITED

Bailey, T. N., A. W. Franzmann, P. D. Arneson, and J. L. Davis. 1978. Kenai Peninsula moose population identity study. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-3 through W-17-9. Job 1.7R. Juneau. 84pp.

Ballard, W. B., A. W. Franzmann, K. P. Taylor, T. Spraker, C. C. Schwartz, and R. O. Peterson. 1979. Comparison of techniques utilized to determine moose calf mortality in Alaska. Proc. N. Am. Moose Conf. Workshop. 15:362-387.

Benesch, F., and J. G. Wright. 1952. Veterinary obstetrics. Williams and Wilkins Co., Baltimore. 459pp.

Craig, J. F. 1912. Fleming's veterinary obstetrics, 3rd ed. Bailliere, Tindall and Cox, Covent Garden, Great Britain. 528pp.

Franzmann, A. W. 1982. An assessment of chemical immobilization of North American moose (*Alces alces*). Pages 391-407 *in* L. Nielsen, J. C. Haigh, M. E. Fowler, eds. Chemical immobilization of North American wildlife. Wisconsin Humane Soc., Milwaukee, Wi. 447pp.

__________. 1985. Chemical immobilization: Carfentanil in moose. Proc. 2nd Wildl. Capture Symp., LaGrande, Or.

__________, and P. D. Arneson. 1973. Moose Research Center studies. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-17-5. Jobs 1.1R, 1,2R, 1.6R, and 1.7R. Juneau. 86pp.

__________, and __________. 1974. Moose Research Center studies. Alaska Dep. Fish and Game. Prog. Rep. Proj. W-17-6. Jobs 1.1R and 1.7R. Juneau. 68pp.

__________, and __________. 1975. Moose Research Center studies. Alaska Dep. Fish and Game. Prog. Rep. Proj. W-17- 7. Jobs 1.14R and 19.15R. Juneau. 129pp.

__________, and W. R. Lance. In press. Chemical immobilization of wildlife: Recent advances. Proc. Int. Wildl. Manage. Symp., Translocation of wild animals. Wisconsin Humane Soc. and Caesar Kleberk Wildl. Res. Inst. Milwaukee, Wi. 1986.

__________, and C. C. Schwartz. 1978. Moose calf mortality study, Kenai Peninsula. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-17-10. Job 1.24R. Juneau. 32pp.

__________, and __________. 1979. Kenai Peninsula moose calf mortality study. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-10 and W-17-11. Job 1.24R. Juneau. 18pp.

__________, and __________. 1982. Evaluating and testing techniques for moose management. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-7 through W-21-1 and W-21-2. Job 1.14R. Juneau. 45pp.

__________, and __________. 1983. Moose productivity and physiology. Alaska Dep. Fish and Game. Final Rep. Proj. W-17-9, W-17-10, W-17-11, W-21-1, W-21-2. Job 1.21R. Juneau. 131pp.

__________, and __________. In press. Black bear predation on moose calves in highly productive versus marginal habitats on the Kenai Peninsula, Alaska. Alces 22.

__________, __________, and D. C. Johnson. 1982. Chemical immobilization of moose at the Moose Research Center, Alaska (1968-1981). Alces 18:94-115.

__________, __________, and __________. 1983. Moose Research Center report. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-22-1. Jobs 1.28R and 1.31R. Juneau. 65pp.

__________, __________, and __________. 1984a. Moose Research Center report. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-22-2. Jobs 1.28R and 1.31R. Juneau. 68pp.

__________, __________, and __________. 1984b. Baseline body temperatures, heart rates, and respiratory rates of moose in Alaska. J. Wildl. Dis. 20:333-337.

__________, __________, and __________. 1984c. Kenai Peninsula moose calf mortality study. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-22-2. Job 1.33R. Juneau. 37pp.

__________, __________, and R. O. Peterson. 1980. Moose calf mortality in summer on the Kenai Peninsula, Alaska. J. Wildl. Manage. 44:764-768.

__________, P. D. Arneson, R. E. LeResche, and J. L. Davis. 1974. Developing and testing of new techniques for moose management. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-2, W-17-3, W-17-4, W-17-5, and W-17-6. Job 1.6R. Juneau. 54pp.

__________, C. C. Schwartz, D. C. Johnson, J. B. Faro, and W. B. Ballard. 1984d. Immobilization of moose with carfentanil. Alces 20:259-282.

Gibbons, W. L. 1963. Infertility in the cow. Pages 382-389 in W. J. Gibbons, ed. Diseases of cattle, 2nd ed. American Veterinary Publications, Inc. Santa Barbara, Ca. 768pp.

Haigh, J. C. 1982. Mammalian immobilizing drugs: Their pharmacology and effects. Pages 46-62 in L. Nielsen, J. C. Haigh, M. E. Fowler, eds. Chemical immobilization of North American wildlife. Wisconsin Humane Soc., Milwaukee, Wi. 447pp.

LeResche, R. E., and J. L. Davis. 1971. Moose research report. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-17-3. Jobs 1.1R through 1.4R. Juneau. 13pp.

__________, and __________. 1973. Importance of nonbrowse foods to moose on the Kenai Peninsula, Alaska. J. Wildl. Manage. 37:279-287.

__________, A. W. Franzmann, and P. D. Arneson. 1973. Moose Research Center report. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-17-4. Jobs 1.1R through 1.4R. Juneau. 166pp.

__________, J. L. Davis, P. D. Arneson, and A. W. Franzmann. 1974. Moose behavior studies. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-2 through W-17-6. Job 1.2R. Juneau. 18pp.

Markgren, G. 1969. Reproduction of moose in Sweden. Viltrevy 6:1-299.

Peterson, R. L. 1955. North American moose. Univ. Toronto Press, Toronto. 280pp.

Regelin, W. L., C. C. Schwartz, and A. W. Franzmann. 1979. Raising, training, and maintaining moose for nutritional studies. Trans. XIV Int. Cong. Game Biol., Dublin, Ireland.

Schwartz, C. C., and A. W. Franzmann. 1981. Moose Research Center report. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-17-11. Jobs 1.14R and 1.21R. Juneau. 49pp.

__________, __________, and D. C. Johnson. 1983. Moose Research Center report. Alaska Dep. Fish and Game. Fed. Aid. in Wildl. Rest. Prog. Rep. Proj. W-22-1. Jobs 1.28R and 1.31R. Juneau. 65pp.

__________, __________, and __________. 1985a. Moose Research Center report. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-22-3. Jobs 1.28R and 1.31R. Juneau. 34pp.

__________, __________, and __________. 1986. Moose Research Center report. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-4. Jobs 1.28R and 1.31R. Juneau. 52pp.

__________, W. L. Regelin, and A. W. Franzmann. 1980. A formulated ration for captive moose. Proc. N. Am. Moose Conf. Workshop. 16:82-105.

__________, __________, and __________. 1982. Male moose successfully breed as yearlings. J. Mammal. 63:334-335.

__________, __________, and __________. 1985b. Suitability of a formulated ration for moose. J. Wildl. Manage. 49:388-393.

Sigman, M. J., and A. W. Franzmann. 1977. Moose behavior studies. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-7 through W-17-9. Job 1.13R. Juneau. 16pp.

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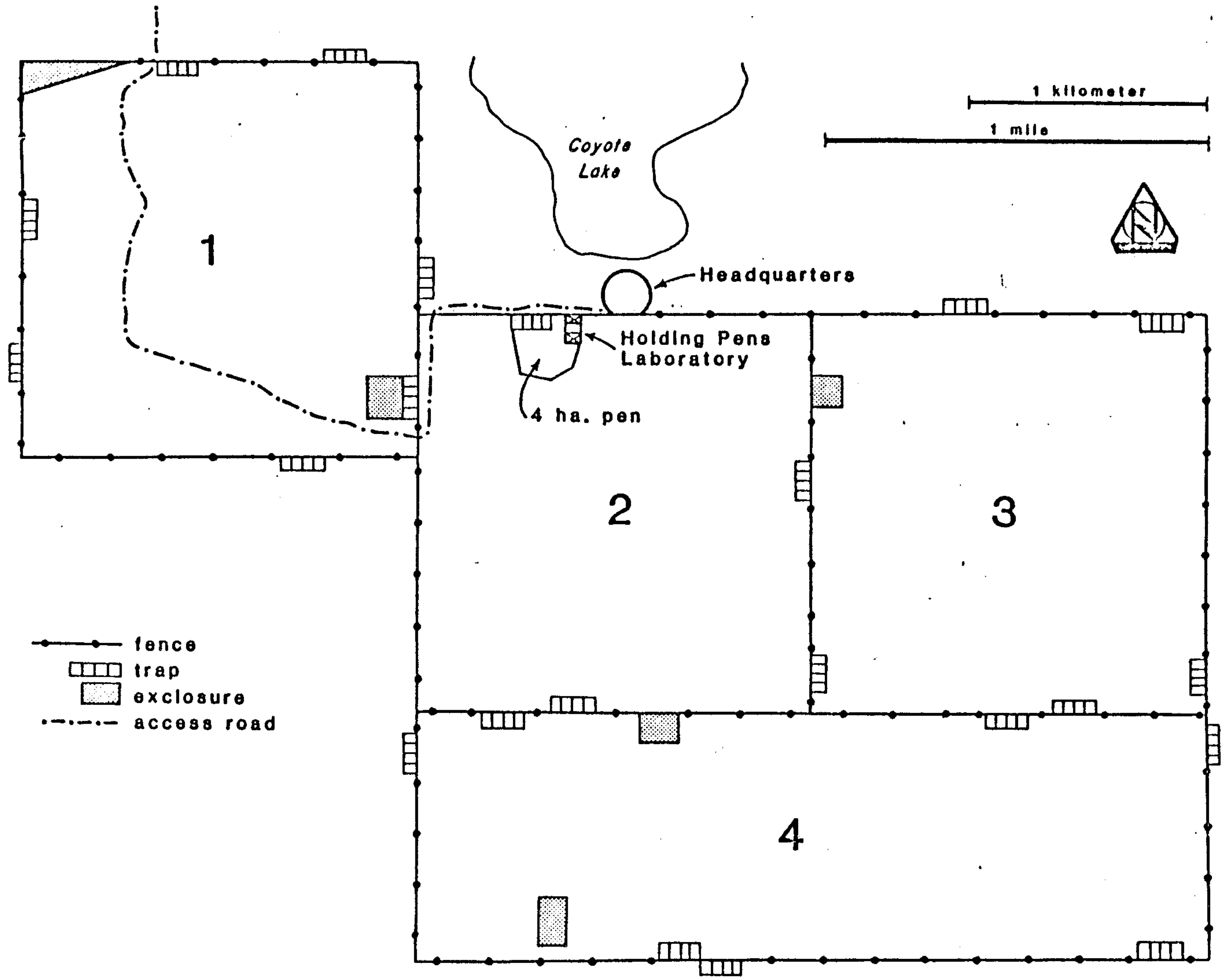

Fig. 1. Moose Research Center diagram.

APPENDIX A

IMMOBILIZATION OF MOOSE WITH CARFENTANIL

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ABSTRACT: From March 1983 through March 1984, 92 adult moose were immobilized using carfentanil. The concentration of the drug (10 mg/ml) allowed the use of small volumes for injection, alleviating some of the problems associated with large-volume dosages. Total dosage per moose varied from 2.5 to 5 mg carfentanil (0.006 to 0.014 mg/kg). Mean induction time for moose receiving at least 3 mg was 5.0 minutes (SD = 2.1, *n* = 75). Diprenorphine (M50-50) was used as the antagonist. During 1983, generally 14 mg were given IV and 6 mg IM. In 1984, dosage was increased and generally 20 mg were given IV and 10 to 20 IM, and 3 moose were given 30 mg IM only. Mean recovery time was 4.2 minutes (SD - 1.9, *n* = 52), excluding the IM-only dosed moose. Hyperthermia, acute capture myopathy and/or narcotic recycling were responsible for 6 mortalities (6.5%). Causes of mortality and ways to minimize it are discussed.

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APPENDIX B

CHEMICAL IMMOBILIZATION OF WILDLIFE: RECENT ADVANCES

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ABSTRACT: Chemical immobilization has been a major method for capturing wildlife in the last 2 decades. The subject was thoroughly reviewed at the North American Symposium: Chemical Immobilization of Wildlife, in 1982. Since capture of wildlife by chemical immobilization has become a useful tool it was necessary to outline recent advances for this symposium on translocating wildlife. In the past 3 years, several potentially useful drugs have become available and this paper will focus on those drugs and their application: namely carfentanil (Wildnil, Wildlife Laboratories, Fort Collins, CO); its antagonists (diprenorphine, M50-50, Lemmon Co., Sellersburg, PA and naloxone hydrochloride, Wildlife Laboratories, Fort Collins, CO); and the xylazine (Rompun, Bayvet Div., Miles Laboratories, Shawnee, KS) reversing drugs (yohimbine, Antagonil, Wildlife Laboratories, Fort Collins, CO; 4-aminopyridine, Sigma Chemical Co., St. Louis, MO; doxapram, Dopram, A. H. Robbins Co., Richmond, VA). There are as well several drugs that have potential use for improving immobilizing techniques which may be available in the near future and which we should discuss. These drugs include the experimental tranquilizers R 51703 and R 51163 (Janssen Pharmaceuticals, New Brunswick, NJ), a narcotic reversing agent (naltrexone, Du Pont Pharmaceuticals, Wilmington, DE), and a drug some may recognize as CI 744 (Telazol, A. H. Robbins Co., Richmond, VA) which may finally become commercially available.

INTERNATIONAL WILDLIFE MANAGEMENT SYMPOSIUM

TRANSLOCATION OF WILD ANIMALS, 1986, Wisconsin Humane Soc. and Caesar Kleberg Wildlife Research Inst., Madison, Wisconsin

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APPENDIX C

BASELINE BODY TEMPERATURE, HEART RATE, AND RESPIRATORY RATE OF MOOSE IN ALASKA

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

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APPENDIX D

SUITABILITY OF A FORMULATED RATION FOR MOOSE

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ABSTRACT: A formulated ration for maintenance or experimental purposes has been developed for moose. It contains 12.7% crude protein and a digestible energy concentration of 2.4 kcal/g. Metabolizable energy concentration is 2.1 kcal/g. Performance was measured over 5 years with data from 11 moose. Daily weight gain in calves from weaning in August through October and from November through April was 0.9 kg ± 0.06 (SE) and 0.4 kg ± 0.03 (SE), respectively, and exceeded those of wild moose. Mean body weights of adult males and females on the diet were greater than those of wild moose. Reproductive performance was also excellent with 83.1% of yearling females breeding and producing a calf at age 2. The ration has been used as the only food of moose for up to 5 years with no apparent adverse effects. It lends itself to constituent alteration for experimental purposes.

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