METHODOLOGY FOR RELOCATING MOOSE

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ABSTRACT: Several different drugs and methods of translocating Shiras moose (*Alces alces shirasi*) from urban and populated areas are evaluated. Since 1988, 126 moose were successfully translocated with 7 mortalities. The advantages and disadvantages of different drugs and drug combinations for capturing moose are discussed and recommendations on the kinds of equipment found suitable for transporting and handling of immobilized moose are presented.

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The capture and relocation of moose from urban areas present unique challenges not encountered by those working in wild settings. Foremost is insuring the safety of bystanders to prevent danger of serious injury from an aroused or partly sedated moose. Traffic control to prevent injury to the moose and vehicle damage from a moose darting out of a yard or alley or running down a street is also important. Another consideration is to minimize property damage to homes, fences, etc. from an aroused moose. The humane treatment of the moose and the professionalism exhibited by the workers are of critical importance because of all the public and media personnel generally present. And finally, there is very little time to plan for the operation or arrange for equipment and specially trained personnel to conduct the capture operation.

Relocation of moose from urban areas also provides positive opportunities. These moose are excellent translocation sources to start new populations in suitable but unoccupied habitat because they are generally younger aged animals or pregnant females. Since the moose are at an undesirable location there is no opposition to relocation from hunters concerned about lost hunting opportunity. And, if successful and humane methodologies for capture and relocation have been developed, the public image of wildlife professionals is enhanced and can receive broad positive media coverage.

Nuisance moose have been a problem in southeast Idaho for the past 15-20 years. However, prior to the mid 1980's nuisance moose were limited to an occasional moose that came into towns during winter or spring when yearling moose were displaced from the dam nearing parturition. Since the mid 1980's the number of moose coming into towns during winter has increased. Additionally, since the mid 1980's Idaho Fish and Game (the Department) has received annual complaints of moose frequenting homesteads, depredating on agricultural crops, damaging fences, and scaring livestock (especially horses).

There are several reasons for the increase in nuisance moose complaints received by the Department since the mid 1980's. Although moose numbers have increased moderately on some of the historical forested ranges, there has been a substantial increase in moose occupying the Snake River riparian areas. This increase in moose along the Snake River riparian area places them in close proximity to towns, homesteads, and ranching operations. Also, in 1990 the Idaho Legislature passed legislation authorizing the Department to compensate agricultural interests for damage caused by big game animals, including moose. This legislation has resulted in the Department being more responsive to complaints from ranchers having moose damage and also a lower tolerance by some ranchers to accommodate moose on their property.

Early attempts by the Department to relo-

cate nuisance moose were often unsuccessful. Moose frequently died from drug overdose at the immobilization site, died while being transported, or failed to recover at the release location. Drugs used were powdered succinylcholine (sucostrin)-xylazine combinations or etorphine-xylazine combinations. Moose were generally kept sedated until released.

In the early 1980's etorphine and later carfentanil was used to immobilize nuisance moose, but the drug was reversed before translocating the moose. This method worked well, but Department administrators were concerned about using potent narcotic drugs within populated areas. A few captures were also attempted using drive nets and physically restraining moose without using drugs. However, only a few younger aged moose were captured by this method. The Method was discontinued because of the high risk of injury to personnel conducting the capture operation and bystanders, and the potential for property damage. By the mid 1980's, Department policy prevented the use of etorphine or carfentanil in populated areas without prior approval from the chief of wildlife. This restriction often prevented a timely response by field personnel to a nuisance moose complaint. Because of this policy restriction, Department personnel began evaluating different immobilizing drugs and drug combinations in an effort to find an effective, humane, and safe drug for capture of moose in populated areas.

METHODS

Darting was done with a extra long range (powder) projector Palmer cap-chur gun (Palmer Chemical and Equipment Co., Inc., Douglasville, Georgia, U.S.A. 30133). Dart needles were barbed large diameter (0.32 mm) and either 2.54, 3.18, or 3.81 cm long. Estimates of weight and physical condition were made by general observation prior to darting.

Immobilized moose were placed on a piece of canvas approximately 1.5 X 2 m and carried to an enclosed horse trailer. In some instances, when a moose was a distance from a plowed road, an old vehicle hood was used as a toboggan behind a snowmachine to transport the moose to the trailer. Efforts were made to keep moose sternal while being carried and when placed in the trailer. When an antagonist was used, it was hand injected intramuscularly after the moose was placed in the trailer. Once in the trailer, the moose was observed until recovery was evident before transport began.

When more than 1 moose was placed in the trailer, calves were gated separate from older animals, and, in some instances, large bulls were gated separate from females and smaller bulls. During summer months when ambient temperatures were above 24°C, moose were wetted down with water to reduce elevated body temperatures associated with drug effects and stress as soon as possible after recovery.

RESULTS

Seven different drug or drug combinations were used to capture 126 moose (Table 1). However, only carfentanil and succinylcholine were found to be effective and acceptable in immobilizing moose. The other 5 drugs and drug combinations were unacceptable because they required multiple darting and large dosages to sedate the moose enough for safe handling.

Carfentanil (Wildnil 3mg\ml) was effective in immobilizing moose. One hundred percent of the moose were immobilized when carfentanil was used, and there were no deaths attributed to the drug. Dosages ranged from 3 mg for moose <1 year old, 3 to 5 mg for 1 to 2 year olds, and 4 to 6 mg for adults. Antagonists used were either 4 mg diprenorphine (M50-50)/mg carfentanil, 150 mg naloxone/mg carfentanil, 100 mg naltrexone/mg carfentanil or 50 mg naltrexone/mg carfentanil.

Succinylcloline chloride (Quelicin 20 mg/

Table 1. Number, age and sex of moose immobilized with seven drugs or drug combinations.

Drug	Adult Male	Adult Female	1-2 Year old	≤1 year	Totals
Carfentanil	3	18	5	7	33
Succinylcholine Chloride	8	21	24	30	83
Telazol				4	4
Xylazine			2		2
Ketamine/ Xylazine			2		2
Telazol/Xylazine		1			1
Carfentanil/Etorphine	1				1
Totals	12	40	33	41	126

ml) was used to capture 83 moose (Tables 1 and 4). Eighty four percent of the capture attempts were successful, 6% were unsuccessful, and 4% resulted from overdose deaths (Table 2). Seventeen percent of the moose captured with succinylcholine chloride were darted multiple times before immobilization occurred, and 17% of the immobilized moose received respiratory assistance to prevent death by overdose.

Moose darted with telazol (1:1 tiletamine:zolazepam) were all less than 1 year old (Table 1), and none was completely immobilized. However, they exhibited some loss of coordination and were physically restrained. Dosages ranged from 1,000 to 2,250 mg. One moose appeared normal when released but was found dead 2 days later near where it was released.

Xylazine (Rompun 100 mg/ml) was used to capture 2, 13 month old moose in June. As was the case with telazol, neither moose was completely immobilized, and they had to be physically restrained. One moose was darted with 300 mg xylazine and redarted 45 minutes later with another 300 mg; the other moose was darted once with 500 mg. Both moose appeared normal when released 7 hours after capture. The moose that received 500 mg xylazine was found dead 3 months later, but cause of death was not determined because of decomposition of the carcass.

A mixture of ketamine (100 mg/ml) and xylazine was used to capture 2, 1.5-year-old

Table 2. Outcome of 119 moose that were attempted to be immobilized.

Drug	Immobilized	Not Immobilized	Drug Death
Carfentanil	33	0	0
Succinylcholine Cl	70	5	3
Telazol	0	3	1
Xylazine	2	0	0
Ketamine/Xylazine	2	0	0
Telazol/Xylazine	1	0	0
Carfentanil/Etorphine	1	0	0

Table 3. Dosages of Carfentanil used to successfully immobilize 32 moose.

	Milligrams
Adult male	4-5
Adult female	4-6
1-2 year old male	4-5
1-2 year old female	3
≤year old	3-4

moose. Neither moose was completely immobilized, although both lost some coordination and were physically restrained. One moose was darted 3 times with 400 mg ketamine and 150 mg xylazine, 100 mg ketamine and 100 mg xylaxine, and 500 mg xylazine, respectively. The other moose was darted once with 500 mg ketamine and 650 mg xylazine.

An adult cow moose was captured using telazol and xylazine. The moose was first darted with 1,500 mg telazol, but it did not stop feeding on ornamental shrubbery. A second dart loaded with 500 mg telazol and 250 mg xylazine hit the moose in the chest and injected the drug combination into the thoracic cavity, immobilizing the moose in less than 1 minute. The moose exhibited typical signs of a heavy overdose of xylazine, so it was reversed with 50 mg yohimbine (Antagonil 5 mg/ml) when released.

One adult bull moose was captured using a combination of carfentanil and etorphine (M99 1 mg/ml). The dosage was 3 mg carfentanil and 1.1 mg etorphine. After darting, the bull ran several blocks through town. Induction time was about 5 minutes. Fourteen milligrams of M50-50 (2 mg/ml) was used for the antagonist, and although the bull partially recovered, he died of renarcotization.

Moose were transported various distances to release locations. Some moose were hauled as far as 300 km and were confined in the trailer up to 15 hours with no apparent detrimental affects. One moose died in transit, but death was believed due to injury when the transport vehicle had to stop suddenly. Moose remained calm while in the darkened trailer.

DISCUSSION

Only 2 of the drugs tested, carfentanil and succinylcholine chloride, were considered acceptable for immobilizing moose. The 4 other drugs and drug combinations, telazol, xylazine, ketamine and xylazine, and telazol and

Table 4. Outcome of 83 moose immobilized with succinylcholine chloride.

	Outcome			
	Immobilized	Not Immobilized	Drug Death	Other Death
Adult male	7	0	1	0
Adult female	19	0	1	1[a]
1-2 year old	9	2	1	2[a,b]
<1 year	25	3	0	2[c,d]
Totals	70	5	3	5

[a]Poor physical condition.
[b]Redruged because too few personnel and inadequate transport equipment allowed too much time to elapse after darting.
[c]Dart hit abdominal area and punctured intestine.
[d]Dart hit abdominal area and moose ran off. Found dead two days later.

Table 5. Dosages (mg) of succinylcholine chloride used on 8 moose.

	Immobilized	Not Immobilized	Overdose Death
Adult male	11-24		22
Adult female	12-20		19
1-2 year old male	10-19		17
1-2 year old female	9-18	9	15
≤1year	6-12	6-8	10

xylazine, caused some loss of coordination, but did not completely immobilize moose. This uncoordinated condition jeopardized the safety of personnel assisting with capture and bystanders and gave the impression of inhumane treatment of moose. The mixture of carfentanil and etorphine would not have been used if enough of either drug would have been available to immobilize the moose.

Carfentanil is currently the drug of choice for immobilizing moose unless policy or legal restrictions prevent its use within and near populated areas. It has a relatively wide safety margin, requires small volume, has ≤5 minutes induction time with predictable effects, and can be quickly and easily reversed. Three milligrams was adequate to immobilize moose less than 1 year old and smaller older moose, and 4 mg was adequate for most moose older than 1 year. Five milligrams may be preferable for large moose that are in excellent condition. Higher doses did shorten the induction time a little, but the suggested dosages will generally result in an induction time of about 4 minutes.

No problem was experienced with carfentanil recycling with any of the antagonists used. I believe this was because the entire dose of antagonist was injected intramuscularly. Naltrexone should be the preferred antagonist, however, because it has a much longer half-life than naloxone, therefore, it virtually elimates the chance of renarcotization. Although the distributor of naltrexone (Wildlife Pharmaceuticals, Inc., Fort Collins, Colorado) recommends using 100 mg naltrexone/mg carfentanil, the 50 mg/ml dose intrasmuscular was found to work equally well.

Some researchers have advocated mixing a tranquilizer such as xylazine to reduce hyperpyrexia when etorphine is used to immobilize moose (Fransmann 1982 and Thorne 1982). Some moose immobilized with carfentanil exhibited hyperpyrexia, but the incidence was no greater than when succinylcholine chloride was used. This may have been because most moose captures were passive, i.e., moose were calm and not chased prior to darting. I believe the positive effects of the moose being completely unsedated during transport outweigh the occasional reduction in hyperpyrexia when xylazine is used in combination with carfentanil.

Succinylcholine chloride was found to be an acceptable immobilant for moose when legal or policy restrictions prevent use of carfentanil. Succinylcholine chloride has been used for at least 30 years to immobilize moose (Fransmann 1982 and Van Ballenberghe 1989). The primary concern when using succinylcholine is its narrow safety margin causing mortality from a relatively small overdose. Every biologist uses a different set of criteria to estimate weights of wildlife and the estimates usually vary between biologists. Therefore, to minimize mortalities, it is critically important for a biologist planning to use succinylcholine chloride to develop a set of criteria that produces consistent weight estimates relative to drug dosages. Moose in urban areas and around farmsteads provide a

better opportunity for estimating weight than moose darted from a helicopter or snowmachine because they can be observed standing at relatively close range.

With experience, Department personnel were able to reduce mortalities from succinylcholine chloride overdose by assisting respiration. The procedure for assisting respiration was to push up and forward on the diaphram with a knee or fist, followed by relaxed pressure. This abdominal-induced breathing provided for some air exchange in and out of the lungs. Usually assistance was required for no more than 15 minutes, but in 1 instance assistance was required for 35 minutes to recover an 8-9-month-old moose.

Induction time is a key indicator of potential succinylcholine chloride overdose. For moose that were calm, an induction time of 6-12 minutes resulted in complete recovery within 25 to 35 minutes. Induction time of less than 6 minutes required close monitoring and frequently the need to assist respiration. Induction times greater than 15 minutes resulted in immobilization times less than 15 minutes.

Moose not immobilized within 20 minutes when succinylcholine was used generally had to be redarted. Redarting can occur 20 minutes after the previous darting without additive overdose. When redarting, the amount of drug was usually increased 1 mg. Exceptions to this were if the first dart hit a fatty deposit, such as the area near the base of the tail; an area of small muscle mass; or further observation suggested a substantial underestimation of weight. When areas of fatty deposit or small muscle mass were hit, a second dart with the same amount of drug used in the first dart was usually adequate to achieve immobilization. If weight was underestimated, the dose was and recalculated the corrected amount of drug used.

The most consistent induction times occurred when 3.81 cm needles were used and major muscle masses of the hip or shoulder were hit. When 2.54 cm needles were used or minor muscle masses were hit there was greater variability in induction time.

Moose that were only slightly underdrugged with succinylcholine chloride frequently exhibited 2 characteristic behaviors. If browse was available, an underdrugged moose would often start feeding. Another characteristic was a sudden shaking, similar to shaking water from pelage after leaving a water body, prior to walking. In some instances a moose would collapse when shaking and was unable to get back up.

Moose were easy to transport unsedated. They remained calm and exhibited no myoneural damage. Thermoregulation was not a problem with trailers ventilated for livestock transport. The one moose lost during transport was injured from a sudden stop.

IMPLICATIONS

It is important that wildlife management agencies have acceptable methods developed to translocate large nuisance wildlife such as moose from urban areas. Capture of moose within urban and populated areas present challenges not always encountered in more wild settings. These challenges include safety of personnel involved in the capture operation and bystanders, restrictions on the use of immobilizing drugs -- especially narcotics, liability for property damage, and public concern for the humane treatment of animals. When an agency has developed acceptable and successful methods, nuisance moose provide good translocation stock and enhance the professional image of the agency. Carfentanil is the best drug currently available for immobilizing moose. However, concern for human safety, policy, or legal restrictions may prevent its use within urban areas.

Succinylcholine chloride was found an acceptable substitute for immobilizing moose in urban areas where use of carfentanil was restricted. The disadvantage of using succinylcholine chloride because of its nar-

row safety margin is reduced somewhat in urban areas because the moose are usually calm and close observation provides more consistent weight estimation. Developing a technique to effectively assist respiration can reduce mortality from drug overdose.

The disassociative, tranquilizing, and disassociative/tranquilizing drug combinations were unacceptable for immobilizing moose in urban areas. These drugs did not completely immobilize moose, which jeopardized human safety, increased the chance of property damage, and could be construed inhumane by the general public.

Transport mortalities were infrequent when moose were allowed to completely recover from drug effects prior to transport.

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