

snowshoes and cottontails were collared for 6 months without ill effects. However, an adult hare was shot wearing a collar which had passed over the ears and become stuck in front of the lower mandible. This individual could not have long survived; its ability to feed was obviously impaired, and it was light in weight.

Tagging snares provide a means for pre-census marking of populations without the necessity of handling animals or checking sets daily. Two potential sources of error are nondetection of tagging failures and multiple tagging. The former is not likely to be of consequence if snare sites are examined carefully. A correction for the latter should be possible by observing rates

of multiple tagging on animals recovered during census periods.

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IMMOBILIZING MOUNTAIN LIONS WITH SUCCINYLC HOLINE CHLORIDE AND PENTOBARBITAL SODIUM¹

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Abstract: Succinylcholine chloride was administered intramuscularly to 13 mountain lions (*Felis concolor*) captured by the use of dogs in western Montana. The average for 19 different dosages was 1 mg of drug for 17.4 pounds of body weight. The average dosage for 12 adult lions in the wild (excluding four juveniles and three dosages to two lions brought in from the field and held in captivity) was 1 mg for 13.1 pounds of body weight. Two lions anesthetized with pentobarbital sodium, after initial immobilization with succinylcholine chloride, received an average dosage of 10.9 mg per pound body weight. Succinylcholine chloride is highly effective for immobilizing lions but should not be administered to treed animals that may be subjected to injurious or fatal falls.

The Montana Cooperative Wildlife Research Unit initiated a 1-year exploratory study of the mountain lion in the fall of

1963 to investigate the feasibility of conducting a long-range ecological study of the lion in its natural habitat. Major emphasis was placed on developing tech-

¹Contribution from the Montana Cooperative Wildlife Research Unit, U. S. Bureau of Sport Fisheries and Wildlife, Montana State University, Montana State Fish and Game Department, and the Wildlife Management Institute, cooperating. The study was financed by the Boone and Crock-

ett Club, the New York Zoological Society, and the Theodore Roosevelt Memorial Fund of the American Museum of Natural History.
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niques for capturing and immobilizing animals so they could be marked and detailed information

MATERIALS AND PROCEDURE

The study was conducted in Montana in an area approximately 140 miles in size, with Missoula near the center. Experienced hunters and trained dogs were hired to capture. Hunting began in mid-December and continued through March, immobilizations occurred during the winter months.

Succinylcholine chloride ("Succinyl" R. Squibb and Sons) was the immobilizing agent used for the work. The concentration was 100 mg of drug per ml for all but four lions; a concentration of 20 mg per ml was administered for the cats. Dosages were computed from the estimate of each lion's weight and its parent condition. After being immobilized each cat was suspended in a nylon net. Its weight obtained on a portable scale. This scale had a capacity of 50 pounds and was graduated in 5-pound increments. The drug was administered by automatic projectile syringes from a gas operated Cap-C (Palmer Chemical and Equipment Co., Atlanta, Georgia). Two exceptions were juvenile lions; they were injected from a 6-foot pole with a syringe attached.

Two lions were anesthetized with pentobarbital sodium following initial immobilization with succinylcholine chloride. The brand was "Pentosol" (H. C. Co., Oakland, California), aqueous solution, in concentration of 60 mg p

RESULTS

Fourteen lions were captured and immobilized. In addition, three recaptured

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RESULTS

Fourteen lions were captured and im-
mobilized. In addition, three recaptures of

marked lions were made during the course
of the study. All lions climbed trees to es-
cape the dogs. Heights climbed varied
from 20 to 80 feet.

Thirteen of the 14 lions were given in-
tramuscular injections of succinylcholine
chloride, most injections being made in the
hip region. Table 1 presents a list of the
lions immobilized with succinylcholine
chloride, the dosage for each cat, and the
length of time each animal was immobi-
lized. A total of 19 dosages was adminis-
tered, with an overall average dosage of
one mg of drug for each 17.4 pounds of
body weight. If four juveniles (which re-
quired lighter dosages) are excluded, the
average dosage for 15 adult lions was 1
mg per 14.2 pounds of body weight. The
dosage for 12 adult lions in the wild (ex-
cluding three dosages administered to two
lions which were brought in from the field
and held in captivity for 1 and 4 days, re-
spectively) averaged 1 mg for each 13.1
pounds of body weight. The maximum
dosage administered was 1 mg per 7
pounds of body weight, given to an adult
female. This was an excessive dose, the
animal requiring artificial respiration for
approximately 10 minutes before normal
respiration was resumed. The minimum ef-
fective dosage was 1 mg for each 40
pounds, injected into a 60-pound juvenile
male.

After injection, an average of 4.05 min-
utes was required for immobilization in
all 19 cases. In 14 instances, average re-
covery time was 23.2 minutes from the time
the animal was immobilized. A lion was
considered immobilized when it was safe
to handle; it was considered completely re-
covered when it ran away from the area.
Recovery was gradual, allowing ample
time for personnel to withdraw to a dis-
tance.

Two lions were anesthetized with pento-

Table 1. Results of administering succinylcholine chloride to mountain lions in Montana, 1963.

SEX	WEIGHT (POUNDS)	TOTAL DOSAGE (MG DRUG)*	DOSAGE MG PER POUND BODY WEIGHT	LATENT PERIOD (MINUTES)	DURATION OF IMMOBILIZATION (MINUTES)
F	105	15.0	1/ 7.0	8	†
		7.0	1/15.0	2	19
		6.0	1/17.5	7	27
F	100	12.0	1/ 8.3	2	24
		6.0	1/16.7	5	13
M	20	1.5	1/13.5	2	Died in fall from tree
M	135	16.0	1/ 8.4	4	60
		14.0	1/ 9.6	3	Died
F	110	6.0	1/18.3	4	14
F	50	1.5	1/33.3	5	15
M	60	1.5	1/40.0	5	15
F	48	1.5	1/32.0	2	Died in fall from tree
M	120	7.0	1/16.4	5	25
F	110	6.0	1/18.3	5	28
M	115	7.0	1/16.4	2	23
F	95	5.0	1/19.0	4	19
M	115	12.0	1/ 9.6	4	20
		13.0	1/ 9.0	5	†
		5.0	1/23.0	3	23

* Represents only single doses; no multiple doses were given.

† Administered pentobarbital sodium before completely recovered from succinylcholine chloride.

barbital sodium following initial immobilization with succinylcholine chloride, as described for brown bears (*Ursus middendorffii*) by Troyer et al. (1962). A 105-pound adult female lion was given 20 ml intraperitoneally, or 1 ml per 5.25 pounds of body weight (11.4 mg per pound body weight). She was completely anesthetized in 10 minutes. This lion was brought into the laboratory and kept overnight. Still completely anesthetized after 3 hours, she recovered the following morning, some 6 hours after injection.

A 115-pound male was injected intraperitoneally with 20 ml or 1 ml per 5.75 pounds body weight (10.4 mg per pound body weight). Anesthesia was complete in 8 minutes. This animal was also brought to the laboratory and after 10 hours was still fully anesthetized. Twenty-four hours later it was able to stand and walk but was not fully coordinated. It appeared completely recovered after 30 hours.

DISCUSSION

Succinylcholine chloride is "a short-acting skeletal muscle relaxant that blocks nervous transmission at the myoneural junction" (Craighead et al. 1960:354). From the standpoint of achieving relatively fast immobilization coupled with rapid recovery of the animal, this drug proved to be excellent for mountain lions. Moreover, of the 19 dosages administered, all were single injections and all were effective.

Consideration, however, must be given factors which were not present in work reported on other species. A fast-acting muscle relaxant is ideal for use on animals which are on the ground when the drug is injected (Bergerud et al. 1964, Harthorn 1965, Talbot and Lamprey 1961). Lions in this study, however, were in trees 20 feet or more from the ground. A fall from this height may be hazardous to an animal completely immobilized.

Three mortalities occurred during the investigation, and two of them were directly attributed to falls. Two lions suffered fractured skulls in falls from trees. Had we been more cautious, these deaths could have been avoided in similar situations later were had an out incident. The third mortality was a 20-pound male, became entangled in a pine and hung for some time in a down position 70 feet above the ground. It regained an upright position after the drug wore off and was allowed to fall for 1 hour. It was then injected with a lighter dose. This additional dose was excessive and the lion died. It was the added stress of hanging head down a total of 60 minutes during the immobilizations contributed to its death.

After these experiences, lions high were forced from the tree a by the dogs in a more favorable position where it could be safely in. Another alternative was to with the dogs from the immediate area low the cat to climb down to a position where it could be safely in. Seven of 14 lions in this study lodged in trees after being in which necessitated climbing to free them. For this reason, should not be administered succinylcholine unless it can be reached in a relatively short time, should it become

Montana, 1963.

LATENT PERIOD (MINUTES)	DURATION OF IMMOBILIZATION (MINUTES)
8	†
2	19
7	27
2	24
5	13
2	Died in fall from tree
4	60
3	Died
4	14
5	15
5	15
2	Died in fall from tree
5	25
5	28
2	23
4	19
4	20
5	†
3	23

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 ycholine chloride is "a short-skeletal muscle relaxant that blocks transmission at the myoneural" (Craighead et al. 1960:354). The standpoint of achieving relatively immobilization coupled with rapid release of the animal, this drug proved to be excellent for mountain lions. Moreover, 19 dosages administered, all were effective and all were effective. Consideration, however, must be given to those animals which were not present in work records on other species. A fast-acting muscle relaxant is ideal for use on animals on the ground when the drug is available (Bergerud et al. 1964, Harthoorn and Lamprey 1961). Lions in the study, however, were in trees 20 feet or more from the ground. A fall from this height may be hazardous to an animal suddenly immobilized.

Three mortalities occurred early in this investigation, and two of them were directly attributed to falls. Two juveniles suffered fractured skulls in falls from trees. Had we been more experienced, these deaths could have been prevented; similar situations later were handled without incident. The third mortality, a 135-pound male, became entangled in a tall pine and hung for some time in a head-down position 70 feet above the ground. It regained an upright position when the drug wore off and was allowed to recover for 1 hour. It was then injected with a lighter dose. This additional dosage proved excessive and the lion died. It is believed the added stress of hanging head-down for a total of 60 minutes during the two immobilizations contributed to its death.

After these experiences, lions treeing high were forced from the tree and re-treed by the dogs in a more favorable position. Another alternative was to withdraw with the dogs from the immediate area and allow the cat to climb down to a lower position where it could be safely immobilized.

Seven of 14 lions in this study became lodged in trees after being immobilized, which necessitated climbing to the cats and freeing them. For this reason, an animal should not be administered succinylcholine chloride unless it can be reached in a relatively short time, should it become lodged.

Our data suggest that juvenile lions require lighter dosages of succinylcholine chloride than adults; this should be considered in further work.

Pentobarbital sodium, because of its lasting effects, was not considered a suitable drug for field use. Provision must also be made to keep anesthetized animals warm. Only when it is necessary to anesthetize a lion for surgery or when more time is required to work on an animal should the use of this drug be considered.

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