February 2004

# Operational Field Evaluation of a Plastic Bulb Reservoir as a Tranquilizer Trap Device for Delivering Propiopromazine Hydrochloride to Feral Dogs, Coyotes, and Gray Wolves

Peter J. Savarie
*USDA Wildlife Services, National Wildlife Research Center*

Daniel S. Vice
*USDA Wildlife Services, Banigada Heights, Guam*

Layne Bangerter
*USDA Wildlife Services, Boise, Idaho*

Kevin Dustin
*USDA Wildlife Services, Richfield, Utah*

William J. Paul
*USDA Wildlife Services, Grand Rapids, Minnesota*

*See next page for additional authors*

# Operational Field Evaluation of a Plastic Bulb Reservoir as a Tranquilizer Trap Device for Delivering Propiopromazine Hydrochloride to Feral Dogs, Coyotes, and Gray Wolves

**Peter J. Savarie**
USDA Wildlife Services, National Wildlife Research Center, Fort Collins, Colorado
**Daniel S. Vice**
USDA Wildlife Services, Barrigada Heights, Guam
**Layne Bangerter**
USDA Wildlife Services, Boise, Idaho
**Kevin Dustin**
USDA Wildlife Services, Richfield, Utah
**William J. Paul**
USDA Wildlife Services, Grand Rapids, Minnesota
**Thomas M. Primus**
USDA Wildlife Services, National Wildlife Research Center, Fort Collins, Colorado
**F. Sherman Blom**
USDA Pocatello Supply Depot, Pocatello, Idaho

**ABSTRACT:** We evaluated a polyethylene bulb reservoir fabricated at the Pocatello Supply Depot, Pocatello, Idaho, as a potential cost savings replacement for the McBride rubber device that is used as a tranquilizer trap device (TTD). The polyethylene devices, also called pipette TTDs, were formulated with 0.6 g of propiopromazine hydrochloride (PPZH) and 0.4 g of ascorbic acid, an antioxidant. The pipette bulb was secured to a 1.6 mm-diameter cable and the cable was attached to the trap jaw. TTD testing was conducted during routine operational control under an Investigational New Animal Drug application (INAD 9528) from the U.S. Food and Drug Administration. The targeted animals were feral dogs in Guam, coyotes in Utah and Idaho, and gray wolves in Minnesota. Various degrees of tranquilization, ranging from quietness and lack of attention to sleepiness, were observed in the animals. Percent of tranquilization effects observed in feral dogs, coyotes, and wolves were 67%, 90%, and 67%, respectively. Evidence of reduced struggling and reduced injuries to feet and legs was observed. Tranquilization effects were also observed in non-target animals such as badgers, skunks, and raccoons. A mortality that was probably related to heat stress was recorded in one juvenile wolf. A major drawback of the pipette TTD was leakage at the stem attached to the trap jaw. Degradation of PPZH was also observed but was reduced compared to formulations without ascorbic acid.

**KEY WORDS:** coyote, feral dog, foothold trap, gray wolf, propiopromazine hydrochloride, tranquilizer, tranquilizer trap device, TTD

**Proc. 21st Vertebr. Pest Conf.** (R. M. Timm and W. P. Gorenzel, Eds.)
**Published at Univ. of Calif., Davis. 2004.** Pp. 64-69.

## INTRODUCTION

A tranquilizer trap device (TTD), attached to the jaw of a trap, contains a drug that causes tranquilization and sedation effects that are beneficial for reducing injuries to animals captured in foothold traps. Use of a TTD takes advantage of a trapped animal's behavior to "attack" the trap and chew on the TTD, resulting in self-administration of the drug by the animal. TTDs containing diazepam were first used in the early 1960s to capture coyotes (*Canis latrans*) relatively unharmed for research purposes. Balser (1965) reported that the onset of action of diazepam was about 30 min in penned wild coyotes with a duration of action in field-captured coyotes that can be as long as 2 - 3 days. Reduced foot and leg injuries, struggling, aggression, escapes, and ease of release of non-target species such as dogs (*Canis familiaris*) were also reported (Balser 1965). Diazepam is a controlled substance regulated by the U.S. Department of Justice, Drug Enforcement Administration (Seal and Kreeger 1987), and never became readily available or authorized for operational use in the TTD.

Savarie and Roberts (1979) evaluated other tranquilizers in coyotes under laboratory conditions as replacements for diazepam. Their tests used behavioral parameters and observations without trap capture to determine tranquilization and sedation effects. Favorable results were obtained with propiopromazine hydrochloride (PPZH), a tranquilizer designed for veterinary use in dogs as an effective aid for handling fractious animals, and for routine examinations including minor surgery (Diamond Laboratories 1970). PPZH is not regulated by the Drug Enforcement Administration, and it was subsequently used in TTDs. PPZH has an onset of action in about 10 - 15 min and duration of action for 18 - 24 h. As high as 90% of coyotes captured in traps with TTDs containing PPZH and checked daily had little or no foot damage (Linhart et al. 1981). PPZH is also effective for reducing foot/leg injuries in captured gray wolves (*Canis lupus*)

(Sahr 1997, Sahr and Knowlton 2000).

The use of TTDs containing PPZH is controlled by USDA Wildlife Services through the Pocatello Supply Depot, Pocatello, Idaho, by an Investigational New Animal Drug (INAD 9528) authorization obtained from the U.S. Food and Drug Administration. PPZH is approved for investigational use in capturing coyotes, wolves, and feral dogs to reduce trap-related stress and injuries and for efficacy testing in other species. Personnel using TTDs on an operational basis must be trained and certified (USDA 1998).

The type of device and its attachment to the trap jaw is critical to the efficacy of the TTD. Efficacy will be decreased substantially for TTDs that cannot be chewed easily or that can be torn off the trap and spit out (Balser 1965, Sahr 1997). Cost and ease of manufacture are also factors that influence use of TTDs. For instance, the balloon TTDs used by Linhart et al. (1981) are time-consuming and labor intensive to make and are not practical or economical for the Pocatello Supply Depot to manufacture on a large-scale operation. The McBride TTD is a commercially available molded rubber device (Livestock Protection Co., Alpine, TX) that is convenient to fill and has been evaluated in both coyotes (Zemlicka and Bruce 1991) and gray wolves (Sahr and Knowlton 2000). The McBride TTD has a hollow nipple that can be filled with the appropriate drug formulation and a slotted base that is attached to the trap jaw. But it is relatively expensive, costing $2.50 each unformulated and $6.80 each formulated with PPZH (B. Petersen, pers. commun.). The present study was conducted to evaluate a less expensive device similar in shape and size to the McBride TTD, but costing only $0.05 - $0.10 each, unformulated. Stability of the formulated PPZH in the TTD without and with ascorbic acid (Vitamin C), an antioxidant, was also evaluated.

## METHODS

The targeted animals were feral dogs in Guam, coyotes in Utah and Idaho, and gray wolves in Minnesota. Trapping was conducted by USDA Wildlife Services personnel during operational control for these target animals at ambient temperatures above freezing and below 32°C. Personnel used staked #3 Victor Soft-Catch traps with rubber-padded jaws for feral dogs, staked #3N Victor traps with smooth off-set jaws for coyotes, and #4 traps (Livestock Protection Co., Alpine, TX) with smooth off-set jaws equipped with drags for gray wolves. Traps were equipped with pan tension devices to reduce non-target captures (Linhart et al. 1981, Phillips and Gruver 1996). Traps were checked daily, except on Guam they were checked twice a day, once in the morning and once in the afternoon, and trapping was not conducted on the weekends on Guam. When an animal was captured, field evaluation assessments of the degree of tranquilization and damage to leg or foot, and mouth or teeth, were recorded on the applicator use record form (USDA 1998). Numerical ratings were assigned to the tranquilization and damage categories for descriptive statistical evaluations (Table 1). Mean values were computed by multiplying each category numerical value by number of samples in the category, totaling the numerical values, and dividing by the total sample number (e.g., 1 animal rated at 1, 3 animals rated at 2, and 2 animals rated at 3; 1×1 = 1, 3×2 = 6, 2×3 = 6 [total = 13]; mean = 13÷6 = 2.2). Target animals were euthanized by gunshot to the head according to Wildlife Services and American Veterinary Medical Association protocols (Beaver et al. 2001). Non-target animals were released, unless their injuries would not allow them to survive in the wild (they were euthanized by gunshot). Two domestic dogs captured in Guam were turned over to an animal welfare organization.

**Table 1. Ratings for field evaluations of degree of tranquilization and damage severity to leg or foot and mouth or teeth for target and non-target animals captured with the pipette TTD.**

| Degree of tranquilization[a] | |
|---|---|
| 1) | Not tranquilized |
| 2) | Quiet, unable to maintain attention |
| 3) | Drowsy, eyes are dull |
| 4) | Sleepy, but could be aroused |
| 5) | Sleepy, could not be aroused |
| 6) | Dead (drug related) |
| **Damage to leg or foot[b]** | |
| 1) | None |
| 2) | Swelling |
| 3) | Minor cut (<2.5 cm long) |
| 4) | Major cut (>2.5 cm long) |
| 5) | Broken Bones |
| **Damage to mouth or teeth[b]** | |
| 1) | None |
| 2) | Mouth laceration |
| 3) | Damage to teeth (incisors, canines, molars) |

[a] from Applicator Use Record form (USDA 1998).
[b] Damage categories from Application Use Record form (USDA 1998) but numerical values assigned by authors.

The TTDs were developed and formulated at the Pocatello Supply Depot. The device tested was a disposable polyethylene transfer pipette with a bulb (reservoir) capacity of about 4.5 ml and a 3.5-cm stem that contained 600 mg PPZH without or with 400 mg ascorbic acid formulated in K-Y Jelly matrix. The stem was sealed with a plastic plug and silicone sealant and a 1.6 mm-diameter wire cable harness loop was affixed to the bulb and stem. A liquid plastic coating applied to the formulated device provided additional strength to the bulb, stem, and cable harness after drying. Except for five TTDs on wolf traps that were attached with hose clamps, the TTD stem with cable was attached to the jaw on the trigger side of the trap with hog ring. Initial field evaluations were conducted without ascorbic acid in the TTD formulation. However, before field evaluations were completed, PPZH degradation was observed and testing was cancelled. Ascorbic acid was added to stabilize the PPZH and only the field data results of TTDs containing PPZH and ascorbic acid are reported.

PPZH was analyzed by the USDA National Wildlife Research Center's Analytical Chemistry Project. Technical PPZH was assayed by Method 56B and PPZH in the formulated TTDs was assayed by Method 83B. Stability

of PPZH without ascorbic acid in the TTDs stored under ambient temperature (20 - 25°C) was determined 174 days after formulation. PPZH with ascorbic acid was determined 539 days after formulation, after the TTDs had been stored at ambient temperature and on traps underground for several days. Statistical significance for the stability of PPZH levels without and with ascorbic acid was determined by the Student's t-test using *Statview* software (version 5.0.1, Statistical Analysis Systems Institute, Cary, NC). Analyses were tested for statistical significance at $P < 0.05$.

This study was conducted with study protocols for each target species (feral dog, coyote, wolf) approved by the NWRC Institutional Animal Care and Use Committee. Since it is known that TTDs reduce severe injuries to captured animals (Linhart et al. 1981, Sahr 1997), to assure that injuries sustained by the experimental, captured animals were as minimal as possible, the Committee would not allow use of a control dose (0 mg PPZH). For the objectives of this study, this decision was appropriate, as it met the criteria for reducing pain and injuries to animals.

## RESULTS

### Stability of PPZH in TTDs

Assay of the technical PPZH used in both TTD formulations (without and with ascorbic acid) was 98.8% (SD = 0.2%, $n = 4$). Initial mean assay after formulation of PPZH in TTDs without ascorbic acid was 636 mg (SD = 5.9, $n = 3$) and after 174 days storage at ambient temperature was 398 mg (SD = 31.4, $n = 3$), a decrease of 37%, which is a significant difference (DF = 4, t = 12.9, $P = 0.0002$). The mean assays for TTDs formulated with PPZH and ascorbic acid also differed (DF = 5, t = 4.9, $P = 0.004$), decreasing from the initial mean assay of 639 mg (SD = 4.5, $n = 5$) to 514 mg (SD = 66.5, $n = 2$), a decrease of 20%, after 539 days under ambient and field conditions.

### Tranquilization and Body Injuries

#### *Feral Dogs*

Degree of tranquilization and damage to leg/foot and mouth/teeth of 6 feral dogs, 2 non-target domestic dogs, and a feral cat (*Felis catus*) captured on Guam are shown in Figure 1. The mean degree of tranquilization was 2.8, ranging from 1 to 4 for the 6 feral dogs, with 4 of the 6 feral dogs (67%) showing signs of tranquilization. Effects of PPZH were readily apparent in the 2 domestic dogs; both were sleepy but could be aroused. The only damage to the leg/foot was swelling, and it was observed in all feral and domestic dogs captured. Three of the 6 feral dogs had no damage to the mouth/teeth and 3 had damage ratings of 3 each, resulting in a mean damage value of 2.0. No tranquilization or body damage was observed in the feral cat.

#### *Coyotes*

Twenty coyotes (9 adult, 11 juvenile) and 5 non-target badgers (*Taxidea taxus*) (3 adult, 2 juvenile) captured in Utah and Idaho had mean degrees of tranquilization of 2.7 or greater ranging from 1 to 4 in coyotes and 3 to 4 in badgers (Figure 2). Of the 20 coyotes captured, 18 (90%) showed signs of tranquilization. Damage to the leg/foot in the coyotes was minimal and the highest leg/foot damage category recorded was a minor cut (<2.5 cm) occurring in only 1 of 20 coyotes. Damage to the mouth/teeth was also minimal, with 16 of 20 coyotes having no damage; 4 of the 20 coyotes had damage to the teeth. Damage was also minimal in the badgers. The highest leg/foot damage category was a minor cut in 2 of 5 badgers, and 1 of 5 badgers had damage to the teeth. Two other adult non-target animals captured, a domestic dog and a bobcat (*Lynx rufus*), had degrees of tranquilization of 3 and 2, respectively, and damage to the leg/foot and mouth/teeth was minimal.

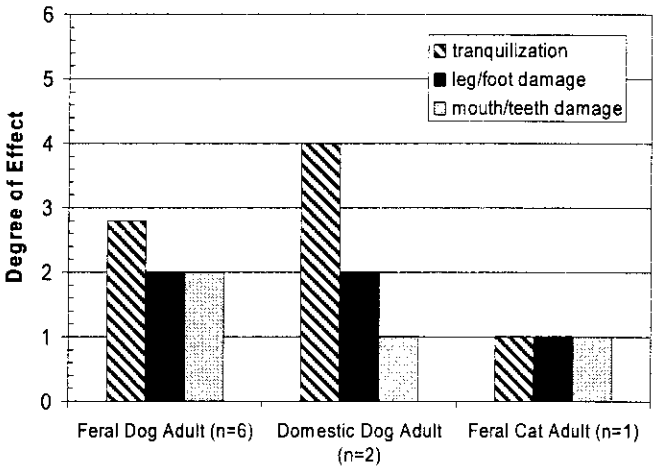


**Figure 1. Mean degrees of effect for tranquilization and damage to leg/feet and mouth/teeth for animals captured in Guam. Feral dogs were the target animals and domestic dogs and feral cat were non-target animals. Refer to Table 1 for numerical ratings of tranquilization or damage categories.**

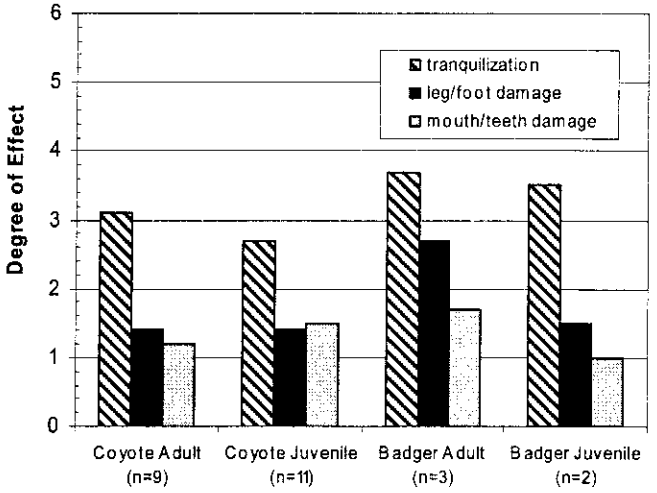


**Figure 2. Mean degrees of effect for tranquilization and damage to leg/feet and mouth/teeth for animals captured in Idaho and Utah. Coyotes were the target animals and badgers were non-target animals. Refer to Table 1 for numerical ratings of tranquilization or damage categories.**

*Wolves*

Tranquilization and injury results for wolves and non-target animals captured in Minnesota are shown in Figures 3 and 4. Sixteen wolves (13 adults, 3 juveniles) were captured, but 1 of the 3 juveniles captured on the edge of an open field exposed to the sun may have been heat stressed and died. Of the remaining wolves, 10 of 15 (67%) had degrees of tranquilization ranging from 2 to 3 (Figure 3). Except for a broken bone that was observed in 1 of the 13 adult wolves, the remainder of the wolves had damage to leg/feet values ranging from 1 to 3 with mean values of 2.4 and 2.5 in adults and juveniles, respectively. Damage to mouth/teeth was not severe, and only 2 of the 15 wolves had damage to the teeth. The 5 striped skunks (*Mephitis mephitis*) were tranquilized and they sustained only minimal leg/foot and mouth/teeth damage. Only 1 of the 3 red foxes (*Vulpes vulpes*) were tranquilized, and all 3 had cuts (2 with minor cuts, <2.5 cm; 1 with a major cut, >2.5 cm) on their legs; 2 foxes (1 fox not checked) had no damage to the mouth or teeth (Figure 3). Both of the coyotes, 2 of the 3 raccoons (*Procyon lotor*), and the bobcat showed signs of tranquilization, and the greatest degree of leg/foot damage was in 1 of 2 coyotes that had a major cut (>2.5 cm) on the leg (Figure 4). A captured white-tailed deer fawn (*Odocoileus virginianus*) did not activate the TTD and it did not sustain damage to the leg/foot or the mouth/feet.

## DISCUSSION

Tranquilizer results in target and non-target animals in the present study compare favorably with field results observed by other investigators with different types of TTDs containing PPZH. Linhart et al. (1981) evaluated 4 different types of TTDs containing 600 mg PPZH with coyotes. For each type of TTD, 75% to 90% of the animals captured had little or no foot damage compared to only 14% for controls where no TTDs were used. Although Linhart et al. (1981) used a different classification system to characterize feet/leg injury, coyote injury results from our study are similar. Linhart's et al. (1981) upper limit classification of "slight or no damage" was cuts "...larger than 0.5 cm but not extending through the skin...". Damage to the leg/foot in 19 of 20 coyotes captured in the present study was recorded as either "none" or "swelling". Using the Linhart et al. (1981) injury classification, 95% of these coyotes had little or no foot damage.

Using PPZH doses of 500 mg and 1,000 mg in McBride rubber TTDs, tranquilization was recorded in 42% and 56% of captured adult wolves, respectively, and tranquilization effects were also observed in non-target animals such as coyotes, red foxes, raccoons, striped skunks, and bobcats (Sahr and Knowlton 2000). The present study used 600 mg PPZH and 67% of the wolves captured had tranquilization effects. In addition to field evaluation of trap-related foot/leg injuries, Sahr and Knowlton (2000) conducted extensive radiographic procedures and necropsies to assess bone and tissue damage and found statistically significant less damage in wolves exposed to PPZH. They also reported tooth injuries were either none or slight in 71% of the wolves examined, but there was no statistically significant reduction in tooth damage in wolves exposed to PPZH. This observation probably relates to their immediate attack on the trap before PPZH was ingested. We also observed low mouth/teeth injury rates to wolves and other target and non-target animals (Figures 1, 2, 3, 4).

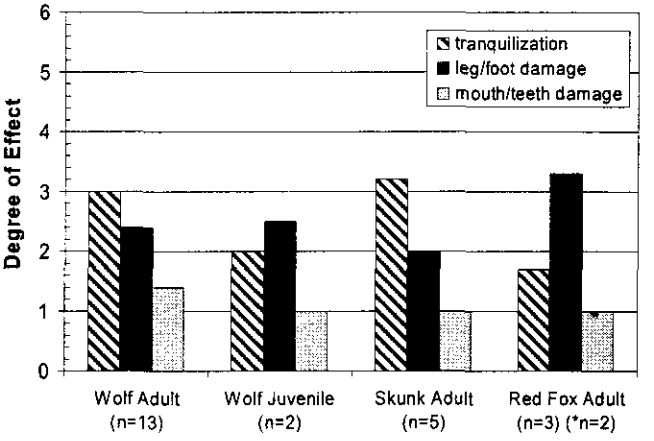


**Figure 3. Mean degrees of effect for tranquilization and damage to leg/feet and mouth/teeth for animals captured in Minnesota. Gray wolves were the target animals and skunks and red foxes were non-target animals. Refer to Table 1 for numerical ratings of tranquilization or damage categories.**

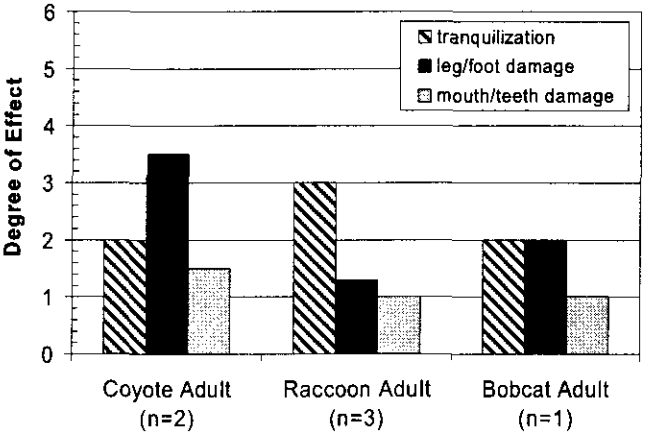


**Figure 4. Mean degrees of effect for tranquilization and damage to leg/feet and mouth/teeth for non-target animals (coyote, raccoon, bobcat) captured in Minnesota. Refer to Table 1 for numerical ratings of tranquilization or damage categories.**

Field evaluations of foot/leg and mouth/teeth injuries in the present study were conducted in compliance to the directions in the applicator use form (USDA 1998) and did not include the detailed examinations conducted by Sahr (1997) and Sahr and Knowlton (2000). Field evaluation, radiography, and necropsy injury assessments were compared for wolves by Sahr (1997). Necropsy was the best technique and identified all of the 23 injury/trauma categories. Field evaluation "most likely" identified 11 of the categories; 7 were "sometimes identifiable, depending on extent of injury;" and 5 were

"not identifiable." Of the 7 categories classified as "sometimes identifiable," 4 ( joint luxation below tarsus or carpus; simple fracture distal to the carpus or tarsus; compression fracture; any fracture or joint luxation on limb proximal to the carpus or tarsus), could compromise survivability of the animal if released. Of the 5 "not identifiable" categories, 2 (major subcutaneous soft tissue maceration or erosion; limb ischemia) could jeopardize recovery and welfare of released animals. Sahr (1997) states that "...field evaluations generally did not accurately assess the extent of injuries." But of the 5 highest injury categories, field evaluation would most likely identify 4 and 1 would be "sometimes identifiable." Extent or degree is a major factor in classifying some of the injury/trauma descriptors. For example, limb ischemia could be slight or so severe that necrosis develops. Necropsy is not an option for animals that are released, but it is not likely that a well-trained field investigator would free an animal in poor condition. If there is concern that a heavily tranquilized animal would not be able to fend for itself, it should be restrained and observed in a cage until it recovers, and then released. However, this is not an issue for animals that are euthanized in the trap.

Based on the collective field experience of several investigators (Linhart et al. 1981, Windberg and Knowlton 1988, Windberg 1995, Sahr and Knowlton 2000), it is an axiom that PPZH will result in tranquilization and reduced foot/leg injuries in targeted animals, and that is the reason researchers use TTDs for translocation and field investigations. For over 30 years TTDs have been routinely attached to traps, involving capture of over 1,200 coyotes, primarily to reduce foot and leg injuries (F. Knowlton, pers. commun.). TTDs were also used to capture wolves in a U.S. National Biological Survey research study (Knowlton and Sahr 1996). These investigators never use a control (0 mg PPZH dose) because they know that without the TTD, major, severe injuries will increase. The positive effects of using PPZH even in wolves recorded as "...tranquility category 1 (alert, active, no drug effect)" was apparent because "...necropsies indicated injuries were reduced among these wolves" (Sahr and Knowlton 2000). A slightly tranquilized animal can be aroused by noise (e.g., vehicles, approaching trappers) and this situation can override its true demeanor before the tranquility evaluation is conducted. But there are three primary reasons that tranquilizers such as PPZH are sometimes not effective: 1) some captured animals of any species will not chew on the TTD, 2) some animals will pull the TTD from the trap and spit it out before ingesting PPZH, and 3) the entire dose is not consumed (Balser 1965, Sahr and Knowlton 2000). Mechanical problems such as providing a stronger TTD attachment to the trap are more easily overcome as compared to the behavioral aspects of an animal not ingesting the PPZH.

As the present study progressed, several problems were identified with the pipette TTDs. First, before field trials could be completed, PPZH formulated without the ascorbic acid antioxidant was found to degrade in the K-Y Jelly matrix, and 37% was lost over a period of 0.5 years at ambient temperature storage room conditions. In contrast, technical PPZH is stable for several years (E. Schafer, pers. commun.). Under laboratory conditions, degradation of PPZH in K-Y Jelly is slowed by adding ascorbic acid but the formulation becomes the consistency of water instead of a gel (T. Primus, pers. commun.). The present study showed that 1.5 years after formulation of PPZH with ascorbic acid, which is not an unusually long time for storage of TTDs used by field personnel, PPZH levels had decreased 20% compared to 37% in 0.5 years without ascorbic acid. PPZH degradation is a potential problem because less would be available for ingestion. Additional field stability studies with PPZH formulated with ascorbic acid or other antioxidants are warranted to determine the minimum dose that would inhibit degradation and still produce effective tranquilization results. Second, several different types of silicon-based sealants were used, but none were completely adequate to seal the pipette stems. Several of the stems leaked under field conditions, making it inconvenient to handle the TTDs and potentially making less PPZH available for ingestion by the trapped animal. Third, wolves captured in traps pulled the TTD and cable harness out from under the hog rings. This is a mechanical problem that can be mitigated by substituting small hose clamps for the hog rings. Hose clamps used on McBride rubber TTDs for wolves have reduced the number of TTDs being torn off (B. Petersen and B. Paul, pers. commun.).

Our data indicate that the pipette TTD is just as effective as the McBride rubber TTD for delivering PPZH to captured animals. Although the initial cost of the unformulated pipette TTD is less expensive than the McBride TTD ($0.05 - $0.10 versus $2.50, with the formulated McBride TTD costing $6.80), the formulated pipette is just as expensive because of the additional labor and materials needed for production. The McBride TTD is more convenient to use and requires only two main procedures for production: filling the rubber reservoir with formulation, and sealing the reservoir. The pipette TTD requires three additional steps: fabrication of the cable harness loop, attachment of the cable harness loop to the pipette, and overcoating with liquid plastic. The McBride rubber device is the only TTD offered by the Pocatello Supply Depot for operational use.

## ACKNOWLEDGEMENTS

We gratefully appreciate the field trapping efforts of Robert Aguero, John Cruz, Duane Sahr, John Hart, and Jeff Grabarkewitz and their contributions to this study. Theresa Buettgenbach, Carol Furcolow, Margaret Goodall, Doreen Griffin, Dennis Kohler, Michael Nelson, and Stephanie Volz conducted the chemical assays for PPZH, for which we are thankful. We thank Tom Mathies for statistical advice and analyses. Use of commercial or trade names does not constitute or imply endorsement by the Federal Government.

## LITERATURE CITED

BALSER, D. S. 1965. Tranquilizer tabs for capturing wild carnivores. J. Wildl. Manage. 29:438-442.

BEAVER, B. V., W. REED, S. LEARY, B. MCKIERNAN, F. BAIN, R. SCHULTZ, B. T. BENNETT, P. PASCOE, E. SHULL, L. C. CORK, R. FRANCIS-FLOYD, K. D. AMASS, R. JOHNSON, R. H. SCHMIDT, W. UNDERWOOD, G. W. THORNTON, AND B.

KOHN. 2001. 2000 Report of the AVMA panel on euthanasia. J. Am. Vet. Med. Assn. 218:669-696.

DIAMOND LABORATORIES. 1970. Tranvet® (propiopromazine hydrochloride) chewable tablets. Diamond Laboratories, Des Moines, IA.

KNOWLTON, F., AND D. P. SAHR. 1996. Assess merits of using tranquilizer tabs for leg-hold traps used to capture gray wolves (*Canis lupus*). Unpublished QA-433 project status report, National Wildlife Research Center, Fort Collins, CO. 7 pp.

LINHART, S. B., DASCH, G. J., AND TURKOWSKI, F. J. 1981. The steel leg-hold trap: techniques for reducing foot injury and increasing selectivity. Proc. Worldwide Furbearer Conf. 3:1560-1578.

PHILLIPS, R. L., AND K. S. GRUVER. 1996. Performance of the Paws-I-Trip™ pan tension device on 3 types of traps. Wildl. Soc. Bull. 24:119-122.

SAHR, D. P. 1997. Merits of using tranquilizer trap devices on leg-hold traps used to capture gray wolves (*Canis lupus*). M.S. thesis, Utah State University, Logan, UT.

SAHR, D. P., AND F. F. KNOWLTON. 2000. Evaluation of tranquilizer trap devices (TTDs) for foothold traps used to capture gray wolves. Wildl. Soc. Bull. 28(3):597-605.

SAVARIE, P. J., AND J. D. ROBERTS. 1979. Evaluation of oral central nervous system depressants in coyotes. Pp. 270-277 *in*: J. R. Beck (Ed.), Vertebrate Pest Control and Management Materials. ASTM STP 680, American Society for Testing and Materials, Philadelphia, PA.

SEAL, U. S., AND T. J. KREEGER. 1987. Chemical immobilization of furbearers. Pp. 191-215 *in*: M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch (Eds.), Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Toronto, Ontario, Canada.

USDA (UNITED STATES DEPARTMENT OF AGRICULTURE). 1998. Tranquilizer trap device handbook (Training, use, and restrictions). USDA Animal and Plant Health Inspection Service, Wildlife Services. 16 pp. + 5 appendices.

WINDBERG, L. A. 1995. Demography of a high density coyote population. Can. J. Zool. 73:942-954.

WINDBERG, L. A., AND F. F. KNOWLTON. 1988. Management implications of coyote spacing patterns in southern Texas. J. Wildl. Manage. 52:632-640.

ZEMLICKA, D. E., AND K. J. BRUCE. 1991. Comparison of handmade and molded rubber tranquilizer tabs for delivering tranquilizing materials to coyotes captured in leg-hold traps. Proc. Gt. Plains Wildl. Damage Control Workshop 10:52-56.