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INTRODUCTION

Increasing public concern about injuries caused by foothold traps has resulted in a considerable amount of research for more humane traps. Much of this research effort has focused on evaluating the Victor No. 3 Soft-Catch trap manufactured by Woodstream Corporation, Lititz, Pennsylvania (Linhart and Dasch 1992). Research has concentrated on two major areas: (1) efficiency and selectivity of different trap types and modifications used for capturing coyotes (Canis latrans) and (2) reducing animal injuries associated with trapping (Phillips and Mullis 1991). The Soft-Catch trap has been shown to reduce foot injury sustained by most captured furbearers (Tullar 1984, Olsen et al. 1986, Linhart et al. 1988, Olsen et al. 1988, Onderka et al. 1990).

Despite its ability to reduce foot injury to trapped animals the Soft-Catch trap has not been widely accepted by trappers. The lack of acceptance is primarily a result of conflicting reports about the efficiency of Soft-Catch traps compared to unpadded traps (Linhart et al. 1986, 1988; LiT and Wnght 1988, Skinner and Todd 1990).

Recent results reported by Linhart and Dasch (1992) indicate the coyote capture rate for the fourth-generation Soft-Catch trap was comparable to that of unpadded models under generally favorable trapping conditions. These authors, however, acknowledge that the trapping conditions of their study area were generally favorable and that further data needs to be collected from other geographical areas under marginal trapping conditions. Recent studies by Holt and Conner (1992) who used Soft-Catch traps for bobcats (Lynx rufus) and coyotes during wet winter conditions, reported much lower capture rates than had been previously reported in western studies. Despite following the manufacturer's trap setting recommendations and the use of dry, light weight soils for trap bedding, the wet conditions seemed to increase the rate of coyote and bobcat pullouts. Capture efficiency for coyotes caught in No. 3 Soft-Catch traps was 0.32 (13 captures and 28 escapes) and for bobcats was 0.66 (12 captures and 6 escapes). The Victor No. 1.75, q-coiled off-set jawed traps used under the same conditions had a capture efficiency of 0.92 for coyotes and 1.0 for bobcats. The senior author has experienced similar results when comparing the No. 3

Soft-Catch and the No. 3 Montgomery coil spring trap while trapping in eastern Mississippi (Houben, unpublished data).

Our pursuit of other trap alternatives that would maintain a high capture efficiency and at the same time reduce foot injuries led us to evaluate the effect of trap jaw design and its role in reducing foot injuries. This study examined the effect of trap jaw design and modification as a means of significantly reducing trap related injuries. The purpose of this paper is to report on the injuries sustained by coyotes caught in No. 3 Northwoods traps with modified jaws and No. 3 Soft-Catch traps with increased spring tension.

ME'fEIODS

Trap Types and Techniques

Coyotes were trapped during the spring and fall of 1992 in north- central Mississippi. Traps were set as part of normal depredation control work for coyotes and checked daily. The legs from 10 consecutive coyote catches were collected from each trap type. The specific traps tested were:

1. Fourth-generation No. 3 Victor Soft-Catch traps with replaceable synthetic rubber-like jaw pads and a 15-cm center-mounted chain with attached coil spring to reduce injury caused by lunging. The factory coil springs were replaced with No. 3 Montgomery music wire springs. This increased the average pressure to depress the spring levers from 110 Kg (50 lbs.) to 154 Kg (70 lbs).
2. No. 3 Northwoods coil-spring traps with offset jaws, modified by Glen Sterling, Faith, South Dakota and marketed by OGorman Enterprises, Inc., Broadus, Montana. The traps were modified by welding a 0.635 cm (1/4 in.) rolled steel lamination strip across the top of each jaw, center swiveling the trap with a Sterling trap base plate, D-ring, and swivel, and bubbling the jaw tips with a weld. The trap chain was 45 cm in length with mid-chain and end-chain swivels, and a shock-absorbing coil spring attached between the end-chain and the mid-chain swivels. The shockabsorbing coil spring was similar to but heavier than the type used on the SoftCatch trap. The milling process used by the factory to produce a 0.635 cm (1/q in.) offset of the trap jaws produced a rough edge on the inside face of the trap jaws. The factory jaws below the lamination strips were filed to remove any burs and to round the jaw edge. An additional set of coil springs was added to the trap using a Taos four coil kit marketed by J. C. Connors, Newcomerstown, Ohio. The average pressure needed to depress the spring levers was 198 Kg (90 pounds).

All traps were staked by attaching a double stake connector to the end-chain swivel. Two 48 cm rebar stakes were driven at opposing 45" angles through the connector to prevent coyotes from pulling stakes from the soft wet soil conditions which persisted over most of the study area.

Leg Injury Analysis

Legs were removed above the elbow, tagged, wrapped in plastic and frozen until

all specimens were necropsied by Mississippi State University, School of Veterinary Medicine. The limbs opposite the trapped limbs were also collected and used as control samples.

Persons conducting the radiological and necropsy procedures were not aware of the trap type in which the coyotes were captured until necropsies were completed. All legs were thawed and radiographed by taking anterior to posterior and lateral views using 12.5 mAs and 55 kVp. Paws were then necropsied and assigned a numerical score (Table I) using a revised Olsen Scoring System (Olsen et al. 1988). The Mann -Whitney U test was used to compare injury scores at the 5% level of significance using SAS (SAS Institute, Inc. 1987). A point estimate of the mean difference in injury scores and a 95% confidence interval were also calculated using the U statistic (Woolson 1987).

RESULT'S

Legs from 20 coyotes were examined (Table 2). All untrapped (control) limbs scored 0. There was no significant difference ($p < 0.2706$) in mean score between limbs of coyotes held in modified Soft- Catch traps and limbs of coyotes taken in modified Northwoods traps. The estimated difference between the traps was 5 points, with a 95% confidence interval of 0-10 points.

Ninety percent of the coyotes captured in both types of traps had cumulative injury scores _< 15 points (Table 2). Scores ranging from 0- 15 reflected small cuts and bruises. From the coyotes captured in modified Soft-Catch traps, 40% had injury scores < 5 (Table 2). Those injuries were limited to edematous swelling and/or hemorrhaging. Fifty percent of the animals caught in modified Soft-Catch traps and 80% of those caught in modified Northwoods traps sustained small cutaneous lacerations and thus received scores of 10-15 points (Table 2). One coyote-captured in a modified Northwoods trap incurred ligament maceration and was assigned a cumulative score of 30 (Table 2). Evidence of chewing the trapped foot was observed twice in the modified Soft-Catch traps. One incident resulted in the amputation of the distal portion of a single digit which resulted in the highest cumulative limb score of 65 (Table 2). There was no evidence of chewing on the trapped feet of coyotes captured in the modified Northwoods traps.

DISCUSSION

Olsen et al. (1988) has suggested that to be acceptable, a trap should significantly reduce serious injuries which is described as limbs having cumulative injury scores > 50 points. Our results indicated that the modified Northwoods trap adequately met this criteria. When compared with the results reported in other studies, the mean injury score for the modified Northwoods trap was less than those of the Soft-Catch trap (Table 3). This difference, however, is small and may not be statistically or clinically important. The reported mean injury scores for coyotes captured in unpadded Victor No. 3 coil-spring traps and Victor No. 3 long-spring traps were 5 times and 7.5 times greater, respectively, than the mean injury score of coyote limbs captured in modified Northwoods traps (Table 3).

The modified Northwoods trap incorporates several characteristics which we feel account for the reduced *injuries.* The lamination of the trap jaws increases the surface area of the jaw face, thereby displacing the energy of the springs over a greater area. This wide, smooth surface reduces the incidence of laceration as the animal's paw moves between the trap jaws. Trap strength combined with offset jaws may also contribute to reducing injuries. The modified Northwoods traps used in this study were four-coiled to increase the spring tension. The increase in the strength of the trap reduced movement of the paw between the trap jaws, thereby reducing any cutting or sawing effect. The importance of trap strength is further illustrated by the mean injury score of the modified Soft-Catch traps which was 14.6 points lower than that reported for standard Soft-Catch traps by Olsen et al. (1988) and 7.6 points lower than that reported by Onderka et al. (1990) (Table 3).

Fractures are a common type of injury observed in unpadded traps. Ninety-one percent of the coyotes captured in unpadded No. 3 Victor long-spring traps by Olsen et al. (1986) sustained fractures, while Olsen et al. (1988) and Onderka et al. (1990) observed a fracture rate of 52% and 48%, respectively, in coyotes captured in unpadded No. 3 Victor coil-spring traps. Fractures were not observed in limbs of coyotes caught in modified Northwoods traps during this study. The absence of these types of injuries may be attributed to the wider than normal offset of the trap jaws and the improved swiveling arrangement. The fracture rate of the unpadded No. 3 Victor long-spring trap observed by Olsen et al. (1986) was almost twice that observed for the unpadded No. 3 Victor coil-spring trap (Olsen et al. 1988 and Onderka et al. 1990). This could be attributed to the longer chain (91 cm vs 15 cm) used on the No. 3 Victor long-spring trap. Our results suggest that an intermediate chain length of 45 cm, combined with the other modifications made to the Northwoods trap, did not result in increase fractures.

Increasing the spring tension by 40 percent in the Soft-Catch traps did not increase the incidence of leg damage incurred by coyotes. When compared with the injury scores reported in other studies of unmodified Soft-Catch traps (Table 3), the increased spring tension may have possibly lowered the mean injury score for coyotes by 7-14 points. A possible explanation for this is that all coyotes captured in modified Soft-Catch traps during our study were caught across the metacarpal region of the foot. Coyotes held by their toes may incur dislocations and fractures while struggling to free themselves. Field observations made before and during our study seem to indicate that increasing the spring tension of the Soft-Catch trap also increases its efficiency. Further *investigation needs* to be made to determine the optimum spring *tension for* the Soft-Catch trap.

Chewing of the trapped foot occurred in two of the ten coyotes taken in modified Soft-Catch traps. There were no observations of self mutilation by coyotes in modified Northwoods traps. Chewing of the trapped foot has been reported in other samples, but its occurrence is rare (R. L. Phillips, pers. commun.) Possible explanations for these observations are: (1) the short chain of the Soft-Catch trap is too confining causing the coyote to focus its attention on the trapped foot; (2) the

Soft-Catch trap is more capable of numbing the coyote's foot than unpadded traps; (3) behavioral differences between individual coyotes and/or study areas.

CONCLUSION

Results of this study indicate the modified Northwoods trap substantially reduces limb injury to coyotes compared to other types of unpadded traps. The design characteristics of the modified Northwoods trap which seem essential are: (1) a doubling of the width of the jaw face by lamination, (2) offset jaws, (3) strong springs, and (4) an improved swiveling system. This data also indicate that increasing the spring tension in the Soft-Catch trap could be done without increasing the injury rate. Future research needs to focus on determining the optimum use of these trap modifications including the optimum spring tension necessary to prevent the paw from sliding between the jaws while not causing excessive tissue necrosis.

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