Factors Influencing the Effectiveness of Breakaway Snares to Capture Coyotes and Release Deer in Alberta

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Background

Coyotes (*Canis latrans*) are important furbearers in Alberta. They regularly rank in the top three of the most valuable furs harvested in Alberta (Alberta Sustainable Resource Development {ASRD} 2003a). In the 2002-2003 trapping season, Alberta fur harvesters exported over 25,000 coyote pelts for a total value of over $1.4 million. Snares are important tools for trapping. A large percentage of coyotes and lynx harvested each year are taken with snares. In a south Texas study, snares were determined to be 10 times more selective for coyotes and bobcat than leghold traps (Guthery and Beasom 1978). Although snares can be set to reduce the capture of non-target species, incidental deer captures do occur. Recent publicity in Alberta regarding the capture of non-targets, primarily deer, has prompted ASRD to make a special note in the trapping regulations (ASRD 2003b) reminding trappers of their obligation to report non-target captures. As pelt values rise, trapper effort may also increase. As more snares are set, the potential for a higher number of deer captures increases.

Breakaway snares were developed circa 1970 to allow for the capture of coyotes and release of deer. Average live weights of female mule deer (*Odocoileus hemionus*) and female white-tailed deer (*Odocoileus virginianus*) fawns harvested in October from Camp Wainwright (Wishart, unpublished data) were 94 and 83 lbs, respectively. Male fawns and adults were much heavier. Maximum weights of 40 and 50 coyotes taken from Elk Island Park and near Westlock Alberta were 37 and 39 lbs, respectively (S. Preuss, unpublished data, L.D. Roy, unpublished data). In theory because the smallest deer in Alberta are heavier than the heaviest coyotes during the trapping season, deer should be able to exert more force on the snare than coyotes. There should be a release force on a snare that will hold most coyotes and allow most deer to escape if the effects of mass are not compensated for by behavior or anatomical differences. Phillips et al. (1990) tested the breaking strength of 3 types of breakaway snares and determined the forces exerted by a sample of coyotes and deer on snares. Although some overlap existed, his data supported the potential to develop effective breakaway devices for snares.

New breakaway devices are being developed and marketed (Grawe's Lures 2003, M and M Furs 2003, Minnesota Trapline Products 2003, Montgomery Fur 2003, Ram Connection 2003, Raymond Thompson 2003, Schmitt Enterprises 2003 and Snare Shop 2003). These devices have different advertised breaking strengths ranging from 90 - 250 lbs. Few of these devices have been field tested to evaluate their performance and little scientific data is available for wildlife managers to base regulations on. Phillips

(1996) field-tested 3 different breakaway devices. Although only 3% of the coyotes activated the release to escape, a whopping 66% of the deer did not escape.

This study is a follow-up to work conducted in 2003-04 (Roy and Twitchell 2004) that concluded that under strict set conditions a Hopkins S Hook breaking at 465 lbs loop pull on a metal pipe approximating the diameter of a coyote's neck would hold most coyotes and release most deer except fawns caught by the neck. These conditions include short snare, solid anchor and open sets that avoid entanglement in nearby brush. This study was designed to determine the breaking force needed to hold most coyotes and release most deer under a variety of set conditions including, entanglement, variable anchoring, differing snare lengths and with and without a tension (kill) spring.

Methods

BREAKAWAY FORCE TESTING

The Amberg release ferrule (Halford Hide and Leather Company, Edmonton, AB, Canada, Model SNAR-E –AMBG2) and different S hooks purchased from hardware stores were tested for breaking strength using a Cooper load cell (Model LRCN750-2K, Inter Technology, Don Mills, ON, Canada) and Data Track readout system (Model 224-1-R, Inter Technology, Don Mills, ON, Canada). The S hooks included the National® 813 and National® 812 closed S hook (National Mfg. Co., Sterling IL, USA, Model N121-434 V2072 and Model N121-392 V2072), National® 3/4" open S hook (National Mfg. Co., Sterling IL, USA, Model N121-533 V2076) and the Stanley® 7/8" closed S hook (The Stanley Works, New Britain, CT, USA, Model 75-9170 CD8471-813). The breaking force of a sample of 10 of each type was determined to measure the associated variability. Breaking forces were measured by pulling straight across the breakaway devices anchored on the lock (straight test) and by pulling against a 2 3/8" diameter metal pipe that mimicked the diameter of a coyote's neck (loop test). These data were combined with data from the Hopkin's 90 lb S hook and the Mullin's shear pin from Roy and Twitchell (2004) to evaluate if straight testing results was predictive of loop testing results.

Additional samples using the National® 813 were tested by breaking them against each of a range of different diameter metal pipes to evaluate the effects of diameter on breaking force, and by breaking them against a rubberized loop to evaluate the effect of substrate composition on breaking force.

COYOTE FIELD TESTS

Snares with a National® 813 S hook as a breakaway were selected and field-tested to evaluate their performance in holding coyotes with and without a Stinger Kill Spring™ (Marty Senneker, Hays, AB, Canada) and with and without entanglement. The coyote snares tested were constructed of 3/32" 7x7 galvanized aircraft cable. They were 5' in length and were equipped with High Desert (High Desert Mfg. USA) cam locks. They were affixed to a Grawe's (Grawe's Lures, Wahpeton, ND, USA) snare support system

(Figure 1). The snare support was 21” high and anchored to the ground using a 3/8” diameter 14”-18” long rebar. The stake had a washer welded to the top and was pounded into the frozen ground.

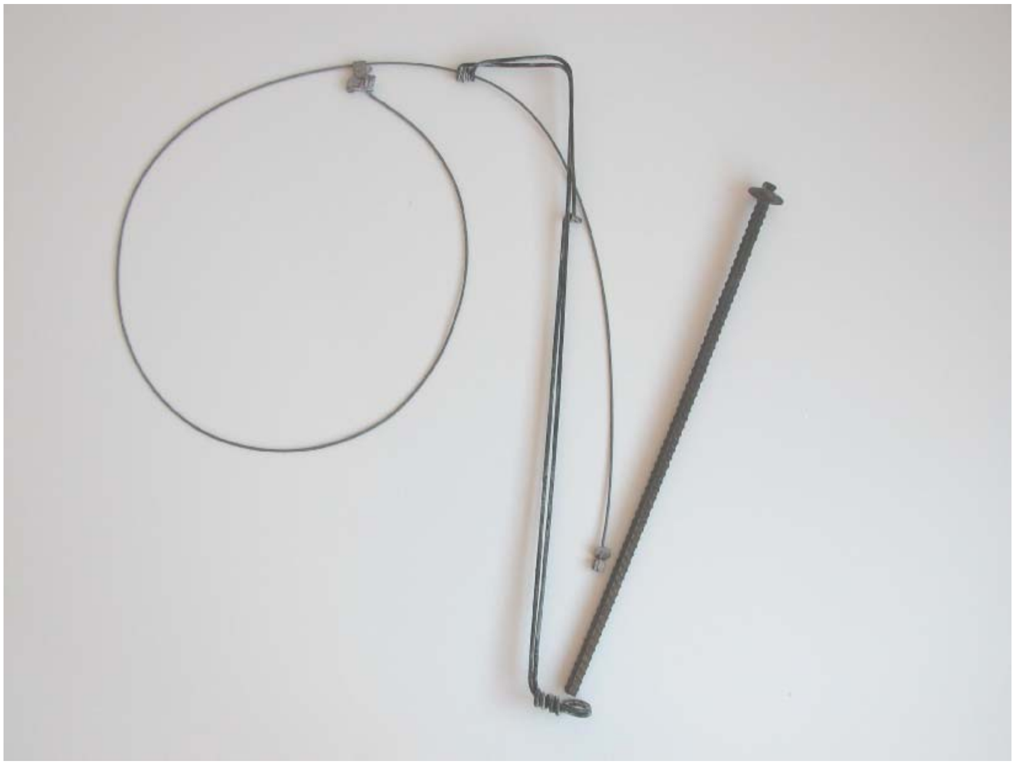

Figure 1. Grawe’s snare support system used to test breakaway snares near Vegreville, Alberta, Canada, during 2004-05.

Additionally, specialized snares were set to capture coyotes to determine a lower threshold breakaway strength that would still hold most coyotes under entanglement situations. The snares were comprised of a National® 3/4” S hook as a breakaway, a Lock-Cam-116BS lock (Halford Hide and Leather Company, Edmonton, AB, Canada) with gripping teeth (Figure 2) filed in using a checkering file (O’Gorman Enterprises Inc., Broadus, Montana, USA) and 1/16” diameter 1x19 steel 12’ long cable with a Stinger Kill Spring™. These specialized snares were anchored to nearby trees and were expected to be among the most effective technology to kill coyotes quickly.

When necessary, captured coyotes were euthanized by a shot to the brain using a .22 calibre long rifle mushroom bullet. Age, sex and weight of coyotes were recorded. We also recorded any stretching of the breakaway S hook >1/16”, the length of free cable from the anchor point of the Grawe’s holding device or trees wrapped by the cable to the snare lock on the coyote and the circumference of the snare around the coyote. The opening (compression) of the kill spring on the coyote was also measured.

Figure 2. Lock-Cam – 116BS cam lock (Halford Hide and Leather Co., Edmonton, AB Canada) with filed gripping teeth used to test breakaway snares near Vegreville, Alberta, Canada, during 2004-05.

DEER FIELD TESTS

Snares with a National® 813 S hook as a breakaway and a Stinger Kill Spring™ attached were also selected and field-tested to evaluate their performance in releasing deer in sets designed to maximize entanglement. The deer snares were the same as the coyote snares except that the length was 12' and they were anchored to available trees (Figure 3).

Age, sex and weight of snare killed deer were recorded. We also recorded any stretching of the breakaway S hook >1/16", the length of free cable from the anchor point of the trees wrapped by the cable to the snare lock on the deer. For deer that broke away, age was estimated by track size and other signs. The length of free cable was measured from the anchor point to the distal kink in the snare cable caused by the lock and the circumference of the snare around the deer was measured from the proximal kink in the snare cable caused by the lock to the end of the snare. The opening (compression) of the kill spring on the animal was also measured.

STATISTICAL ANALYSES

All statistical analyses were performed using SAS Release 9.1 for Windows. Statistical procedures were selected based on the distribution of the data and the validity of the assumptions. The relationship between force and circumference was analyzed using a

Figure 3. Snare sets designed to catch deer used to test breakaway snares near Vegreville, Alberta, Canada, during 2004-05. Note attached Stinger Kill Spring™.

one-way analysis of variance. A two-sample t-test was used to compare the breakaway force between a rubberized and steel loop. The relationship between type of device and type of pull with breakaway force was analyzed using an analysis of variance model with type of device, type of pull (straight or loop), and the two-way interaction as fixed effects. The breakaway force was normalized using a log-transformation for this analysis. For the analysis of variance models, if the model revealed statistical significance ($P<0.05$), Tukey-Kramer adjusted comparisons were used to determine if pair-wise differences existed between the circumferences. Satterthwaite's estimate of degrees of freedom was used for the analysis of variance models. A linear regression model was fit to determine the strength of the relationship between breakaway forces for straight pulls compared to loop pulls. Fisher’s exact test was used to evaluate the effect of entanglement and kill springs on coyote breakaways and killing efficiency.

All animals used in this study followed approved protocols under the Guidelines of Canadian Council on Animal Care, Guidelines on: The Care and Use of Wildlife (CCAC *ad hoc* Committee. 2003).

Results and Discussion

BREAKAWAY FORCE TESTING

The average forces required to activate (break) the different breakaway devices varied from 79.4 to 146.4 lbs under straight pull testing and between 206.9 and 350.1 lbs under loop testing (Table 1). Overall there was a significant (P=0.0039) predictive relationship between straight and loop breaking forces (Figure 4). However strength of the relationship changed (decreased) when individual breakaway types were removed from the sample.

Table 1. Breaking strength (N=10) of 5 breakaway models tested at Vegreville, Alberta, Canada during 2003-05. Testing was completed using 3/32" airplane cable and High Desert cam locks as a straight pull and as a loop pull against a steel pipe 6.0 cm in diameter.

Breakaway Model	Test Type	Breaking Strength (lbs)		
		Mean	SE	Range
*National 813	Straight	125.5	3.53	38
	Loop	307.9	8.34	134
National 812	Straight	146.4	2.58	24
	Loop	350.1	9.12	96
Stanley 7/8"	Straight	96.9	3.97	40
	Loop	271.4	12.42	113
National 3/4"	Straight	79.4	2.18	19
	Loop	206.9	8.45	79
Amberg Release Ferrule	Straight	116.2	3.30	37
	Loop	274.9	16.00	186

*N = 15

Loop size also affected breakaway strength (Figure 5). Breakaway strength at 2 3/8" was higher than at 1 5/8, 4 1/2 and 6 5/8 inches (P=0.0007, P<0.0001 and P<0.0001, respectively), breakaway strength at 7/8" was higher than at 4 1/2 and 6 5/8 inches (P<0.0001 and P<0.0001, respectively) and breakaway strength at 1 5/8" was higher than at 4 1/2 and 6 5/8 inches (P=0.0210 and P<0.0004, respectively). When a pulling force is applied against a loop, the force is spread around the loop including on the breakaway device. Different configurations of breakaway devices result in different forces exerted on the breakaway device. When the snare was tightened on the metal loop using cam locks, the shape at breaking was "tear drop" rather than round. Differing configurations affect the pulling force needed to activate the breakaway device at different diameters.

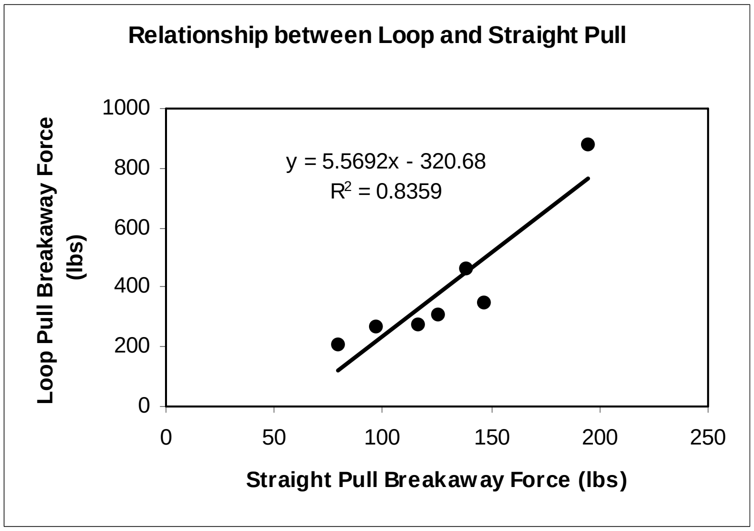

Figure 4. Relationship between loop and straight pull testing of breaking force of 7 different breakaway snare devices tested near Vegreville, Alberta, Canada, during 2003-05.

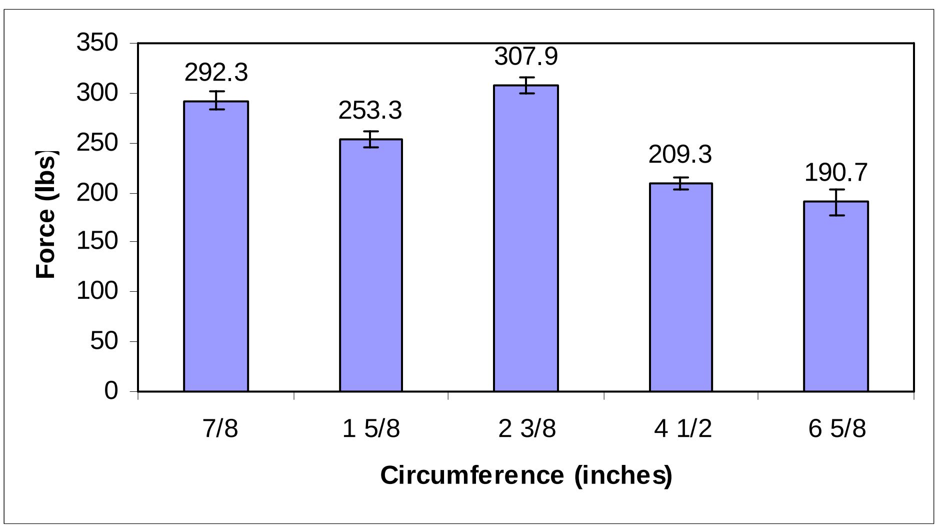

Figure 5. Relationship between breaking strength and loop size of the National 813 S hook tested at Vegreville, Alberta, Canada, during 2004-05.

The breaking force of the National 813 was lower (P<0.0001) on a 2 3/8" rubberized loop ($\bar{x}$ =201.3 $\pm$ 5.43) than a 2 3/8" steel loop ($\bar{x}$ =307.9 $\pm$ 8.34). The steel pipe we used is likely to produce different results than on an actual animal because embedding of the snare wire into the animal would likely result in a different force distribution around the loop than on solid steel where no embedding occurs.

Many factors influence the force measurements required to break breakaway devices. Type of testing (straight vs loop test), loop size, the cushioning properties of the loop and type of pull (dynamic vs static) all affect breaking forces. Although we do not know the true breaking force required under real trapping situations, we suggest that standardized testing of breaking strength using a 2 3/8" diameter steel pipe would be more applicable than the straight pull tests presently used. Because 2 3/8" diameter mimics the size of a coyote neck this is the loop size most applicable to snaring coyotes. We would also suggest using a dynamic testing system rather than the static system we used to remove the effects of binding of the S hook in the lock (Roy and Twitchell 2004).

COYOTE FIELD TESTS

During 489 snare nights set to capture coyotes using the National® 813 S hook as a breakaway device, we captured and held 23 of 25 coyotes and captured and held 2 of 3 deer. The 2 deer killed, 1 female and 1 male fawn, weighed 72.6 and 81.4 lbs, respectively.

An equal ratio of male to female coyotes (P=0.2615) was captured ranging in weight from 17.8 to 37.6 lbs (Table 2). These coyotes represented a reasonable sample of typical sized coyotes. Coyotes of up to 39 lbs have been recorded in Alberta (L. D. Roy 1976, unpublished data).

Table 2. Age, sex and weight of coyotes snared using the National® 813 S Hook breakaway snares at Vegreville, Alberta, Canada during 2004-05. The sample includes 4 coyotes captured in the snares and excludes 1 juvenile coyote that was not sexed.

Age/Sex	Mean Weight lbs (SE)	N
Adult Male	32.2 (0.9)	14
Adult Female	27.2 (1.2)	5
Juvenile Male	24.9 (1.0)	3
Juvenile Female	21.7 (1.7)	4
Total	28.8	26

We used the neck-captured coyotes with the National® 813 to evaluate the effects of entanglement and kill springs on breakaways. There was no significant effect of entanglement (P=0.4935) and kill springs (P=0.1948) on breakaways (Table 3). Although 2 of the first 4 coyotes captured with the National® 813 broke away, they were the only breakaways in this test. We believe that the breakaway strength of the National® 813 S hook was too high for the entanglement and kill spring tests to be effective.

Table 3. Number of breakaways and number of coyotes dead at the 24 h check of coyotes snared by the neck using a National® 813 S hook breakaway snares at Vegreville, Alberta, Canada during 2004-05.

Snare Type	N	Number Entangled	Number of Breakaways	Number of Mortalities
Standard	10	5	2	5
Kill Spring	12	4	0	4

Since the only 2 breakaways occurred with no kill spring and no entanglement and based on the data from Roy and Twitchell (2004) and the other data presented in this report, we believe that entanglement reduces the breaking strength needed to hold coyotes and deer. Breakaways occur as a result of impact force equalling mass times acceleration. Entanglement and likely the kill springs act to reduce acceleration of the snared animal and the impact force on the device, thereby reducing the ability of the capture animal to breakaway.

We used the same neck-captured coyotes to evaluate the effects of entanglement and kill springs on killing effectiveness. There was a significant effect of entanglement (P=0.0009) but not of kill springs (P=0.3618) on mortality of coyotes at the 24 h check (Table 3). Most (89%) of entangled coyotes were dead at the 24 h check while few (9%) of non-entangled were dead. Entanglement with kill springs resulted in 3 of 4 mortalities and without kill springs resulted in 5 of 5 mortalities. The opening (compression) of the kill spring for 12 captured coyotes ranged from 0.3 to 1.9 and averaged 1.3 inches. The mean compression was equivalent to 17 lbs of pressure (Figure 6) and would be expected to increase the killing effectiveness of the snares. The kill springs may not have been applying force against the locks in a manner to contribute positively to tightening the locks or the locks may not have been efficient enough to take advantage of the kill spring. Longer snares to activate the kill springs, smaller diameter snare cable and more efficient locks may be needed to optimize the killing effectiveness of kill springs.

We also captured 4 coyotes in 84 trap nights using specialized snares and a National® 3/4” S hook as a breakaway. The one coyote (25%) not held by this set was anchored to a solid tree and in a very open area. One coyote held by the snares was caught by the chest and two coyotes were caught by the neck. Both neck captures were entangled and dead at the 24 h check and partially frozen. Freezing temperatures overnight (-15°C), above freezing temperatures during the day (2°C) and minimum site disturbance indicated that these coyotes died quickly. The smaller diameter cable may be more effective at killing coyotes quickly because it embeds deeper into the neck tissue to occlude the trachea and carotid arteries. A lower breakaway force of 200 lbs may hold a significant number of coyotes if sets are selected to maximize entanglement and are anchored on smaller trees that provide cushioning.

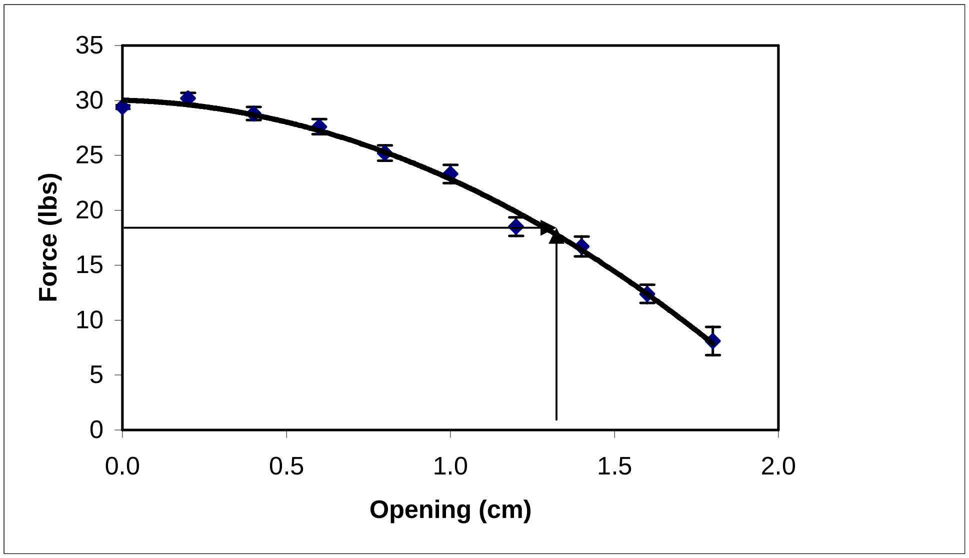

Figure 6. Force generated by Stinger Kill Spring™ at different levels of compression (openings) at Vegreville, Alberta, Canada during 2004-05. The average opening of the springs on a sample of 12-snared coyotes was 1.3 inches.

<u>DEER FIELD TESTS</u>

During 248 snare nights set to capture deer using the National® 813 S hook as a breakaway device, we captured and held 4 of 20 deer and 4 of 4 coyotes. The 4 deer killed, 2 female and 2 male fawns, weighed 68.2, 74.8, 92.4 and 92.4 lbs, respectively. Including 2 of 3 deer held in coyote snares, 74% of 23 deer broke the National® 813 S hook.

Estimated circumference of snares on deer was used to estimate the position of the snare on the deer (Table 4). We estimated that 20 of 23 deer, (87%), were caught by the neck, one by the leg and two by other positions. Positions classified as “other” likely involved the body, antlers or combinations of leg, neck body or antlers. Based on signs at the site, (mostly track size), we estimated that 9 deer were adults, 8 deer were fawns and 6 deer were of unknown age. We believe that most of the deer we captured that broke away were not held for long, as the trapping site was either mildly or undamaged.

Deer snares were set high off the ground in a large loop to capture deer by the neck as a most extreme test. In normal coyote snaring situations fewer deer would have been captured by the neck and more deer would have been captured by the legs. Roy and Twitchell (2004) captured 4 of 6 (66.7%) deer by the leg using coyote snares. Leg captured deer have more opportunity to breakaway than deer captured by the neck that die quickly. Thus we believe that in normal coyote snaring activities with the National® 813 S hook, more than 74% of deer would break away.

Table 4. Estimated snare position and circumference of deer snared using a National® 813 S hook breakaway snares at Vegreville, Alberta, Canada during 2004-05.

Snare Position	N	Mean Circumference Inches	SE
Leg	1	2.8	NA
Neck	20	10.0	0.5
Other	2	27.7	5.7

The only deer held by breakaway snares using the National® 813 S hook were fawns that were captured by the neck. Entanglement occurred in 4 of 23 deer and since 2 of the 4 entangled deer were killed, entanglement may also have contributed to the breakaway not releasing because of the cushioning effect of the small sapling and because the effective snare length was reduced. Phillips (1996) also reported that entanglement, cushioning and quick killing snare designs would affect the forces required to activate breakaway releases.

SUMMARY

Many factors influence the effectiveness of breakaway devices. A greater loop size decreased breaking forces indicating that a snare around a deer's body would require less force to break than one around a leg. Phillips (1990) also indicated variability in forces generated by individuals of a species and an increase in forces generated by coyotes with increased snare length. These findings together with the variability of breaking force of present breakaway devices indicate that improvements in effectiveness are possible with improved designs, but that because of the variability of forces generated by individual animals and the variability of position of the snare on an animal that even improved breakaways will not function 100% of the time.

In total under varying trapping conditions, the National® 813 S hook held 93% of 29 coyotes and released 74% of 23 deer. The only 2 coyotes that broke away were on solid sets with no entanglement and no kill springs. No adult deer were held using this S hook as a breakaway. Since the sets used represented a variety of sets used by trappers using snares, we believe that breakaway devices with a similar breaking strength of the National® 813 S hook would fulfil the mandate of holding most coyotes and releasing most adult deer in most coyote snaring situations. However, devices breaking at higher forces are needed for solidly anchored sets in shrubby or grassy areas where entanglement would not occur.

Under entanglement situations, we suggest that the breakaway device should break at approximately 250 lbs when tested on a 2 3/8" diameter steel pipe. The ideal set would use a long snare (≥12') and 1/16" diameter snare cable with an effective lock and kill spring attached anchored high in a smaller sapling that provides some cushioning. The longer and smaller diameter snare is to allow the coyote a good run at the snare and to set the snare deep in the neck muscles of the coyote to increase killing effectiveness.

The higher anchoring is to distribute more of the force on the ventral part of the neck to occlude the trachea and carotid arteries. Finally the smaller sapling is to provide cushioning to prevent coyotes from activating the breakaway. The objective is to find a balance between cushioning and a solid enough anchor to embed the snare in the neck of the coyote. The snare loop should be $\geq$10” off the ground and $\leq$12” in diameter to more effectively target the neck of coyotes and avoid deer.

Management Implications

Coyotes and deer are found together throughout Alberta. Because snares are very important tools for trappers and for problem wildlife control and because deer and other ungulates are a valuable resource for consumptive and non-consumptive use, we recommend that devices such as breakaway snares be considered in the regulations governing snare use. Regulations should differ between provinces as coyote and deer weights vary between regions. Eastern coyotes are heavier than those in Alberta and some populations of white-tailed deer such as those in southern Saskatchewan are smaller than those found in Alberta or northern Saskatchewan.

Most of the breakaway devices available on the market today have too high a breakaway force to allow all but the very large deer to escape. This is already changing based on the data reported by Roy and Twitchell (2004). Breakaway snares with an S hook breaking at 300 lbs (tested on a 2 3/8” diameter steel loop) will hold most coyotes and release most deer in Alberta. A lighter breakaway device with an S hook breaking as low as 200 lbs used with 1/16” diameter snare cable and quicker killing locks and kill springs used in brushy areas where entanglement is more likely to occur would likely still hold most coyotes and release more deer. Breakaway devices used for snaring coyotes in Alberta should release at breaking forces at or below 465 lbs to release adult deer. Lower breakaway forces are needed to release deer fawns.

We recommend further testing on the effects of snare diameter, snare length, lock efficiency and kill springs on the killing effectiveness of snares for coyotes. Trapper education on snaring is invaluable to ensure breakaway devices and quicker killing designs are used effectively.

Acknowledgements

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