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ELECTRONIC MEASUREMENT OF CLOSURE SPEED FOR STEEL FOOTHOLD TRAPS

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Trapping is a primary method used by the U.S. Fish and Wildlife Service to take coyotes (*Canis latrans*) preying upon livestock. Increased public concern over traps and efforts to prevent their use led the Denver Wildlife Research Center to institute studies in 1980 to evaluate foothold traps with jaws padded to reduce injuries to captured coyotes. Along with

data on trap-caused injury (Olsen et al. 1986) and trap effectiveness (Linhart et al. 1986), information on the closure speed of unpadded and padded traps was needed. Closure speed may affect capture rates, especially of those species behaviorally adapted to respond rapidly to threatening situations. It is also a measure of trap jaw striking or clamping force, which may affect the severity of injury sustained by captured animals. Closure speed thus affects trap performance, but other than high speed photography (Fed. Prov. Comm. for Humane Trapping, unpubl. rep., Prince Edward Isl., Can., 1981; M. Novak Ont. Minist. Nat. Resour., pers. commun.) no other techniques for measuring trap speed have been described. We developed a procedure to easily and rapidly measure this speed so that different types of traps could be compared.

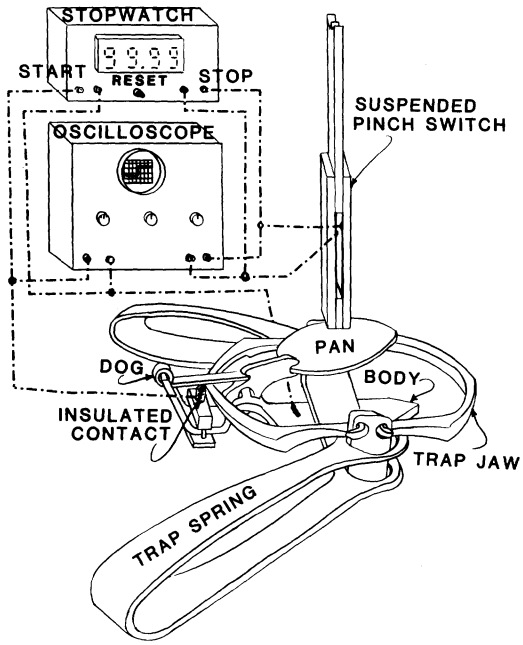

Fig. 1. Method developed to measure closure speed of steel traps. Speed in milliseconds was recorded from trace on face of oscilloscope or from digital readout on stopwatch.

METHODS

Trap closure time is defined as the interval between the initial movement of the trap dog and closure of the trap jaws. The dog holds the jaws open until the pan is depressed, thus releasing the dog and jaws (Fig. 1). Because commercial switching devices had time delays and were not suitable for taking these measurements, we used the trap dog and an insulated contact as a "first-movement" switch to measure the start of jaw closure. The insulated contact was constructed from a block of polyvinyl chloride and measured about 1.0 × 4.0 cm. The block was tapped for a No. 10 machine screw, which was used for the contact and adjusted up or down to make contact with the dog when the trap was set. Two No. 4 machine screws were placed through each end of the block to clamp it to the trap cross (Fig. 1).

A mechanical pinch switch was designed to sense the instant of trap closure. It consisted of 2 electrically isolated, copper-coated epoxy glass boards which were pinched together when the trap closed. The pinch switch measured about 2.5 cm wide × 10.2 cm high, excluding the mechanical support piece. Wires were soldered to the conducting surfaces of the pinch switch for connection to the measurement circuitry, a Tektronix 7613[1] storage oscilloscope, and a Hewlett-Packard power supply. We also tested an electronic stopwatch (NES Incorp., Model DS 1558) for measuring closure speeds. This system included the stopwatch, a 5 Vdc power supply, and the identical insulated contact and pinch switch described above. Calibration and resolution of the oscilloscope and stopwatch were ±200 and ±10 microseconds, respectively.

Each longspring trap (Woodstream Victor 3 NR and 3 NM) was placed in a jig and the trap set with the springs adjusted so that they were set 45 degrees to the center of the jaw posts. The insulated contact beneath the dog and the pinch switch were connected to the oscilloscope or stopwatch (Fig. 1). The trap pan was depressed from above with a 0.30-cm diam steel rod having a diameter smaller than the pinch switch and the jaw closure time was read in milliseconds directly from the oscilloscope or the digital display on the stopwatch. Closure speeds were measured with the trap clamped in a machinist's vise or with the trap set in a box of soil to simulate field use. Traps were set in dry clay loam soil in the same manner as that employed by trappers, i.e., a hole was dug to accommodate the trap and it was firmly "bedded." Measurement connections to the trap were made and a trap-pan cover (plastic sandwich bag) was placed over the pan and under the jaws. Soil was then sifted over the set with a 0.6-cm wire screen sifter and packed firmly around the trap springs and jaws. The soil was then brushed off until the top of the trap pan was exposed. A 0.6-cm-thick steel nut was temporarily placed on the center of the pan to measure and insure consistent

[1] Reference to trade names does not imply endorsement by the U.S. Government.

Table 1. Analysis of variance from which devices measuring trap closure speed were compared and from which sources of variation were estimated.

Source of variation	df	Mean square error
Trap	9	27.463
Reps within trap	20	5.107
Device[a]	1	0.088
Device × trap	9	0.506
Device × reps without trap	20	0.715
Total	59	

[a] Device is the only fixed (and therefore tested) effect. The error term for testing this effect is Device × Trap interaction.

dirt thickness and to pinpoint the center of the trap pan for later positioning of the pinch switch. Dirt was again sifted over the set and brushed level with the steel nut, leaving 0.6 cm of soil on top of the pan. The steel nut was removed and the lower end of the pinch switch was suspended over and 0.5 cm above the center of the trap pan. The pinch switch was connected to the measurement equipment, the pan was depressed, and the closure time was taken from the measurement trace stored on the face of the oscilloscope or from the digital display of the stopwatch. For the purpose of comparing oscilloscope and stopwatch measurements, we wired both instruments such that simultaneous readings were taken for the same trap (Fig. 1).

RESULTS AND DISCUSSION

The procedures and measurement equipment satisfactorily measured the closure speeds of padded and unpadded Woodstream Victor No. 3 double coil and 3N longspring traps. Both oscilloscope and stopwatch functioned well but the stopwatch was easier to read and cost less ($500 vs. $12,000). Because steel traps are relatively crude mechanical devices, considerable variation in closure speed was found both within individual traps as well as between traps of the same type (see mean square errors, Table 1). However, these sources of variation were not of a magnitude to preclude comparing different type traps (Linhart et al. 1986). Simultaneous measurements of the same trap taken by both oscilloscope and stopwatch were similar ($F_{1,9} = 0.12$, $P > 0.50$). Of 60 closure-speed measurements, the mean closure time using the oscilloscope was 0.01859 sec vs. 0.01852 sec for the stopwatch. We recorded measurements directly from the oscilloscope, but they could also be photographed for permanent record and future analysis. Battery-operated equipment is available if measurements in the field are required.

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