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Test Methods for Steel Foothold Traps: Criteria and Performance Standards

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ABSTRACT: Controversy over the continued use of steel traps for capturing wildlife has increased in recent years. Despite the great number of different types of traps and their widespread application for harvesting fur, controlling wildlife damage, and carrying out other wildlife management objectives, few tests of performance have been conducted and no standard test methods have been published. This paper lists and describes some of the physical criteria and laboratory and field tests needed to determine performance, including efficiency, selectivity, and injury sustained by captured animals.

KEY WORDS: trap, foothold, criteria, capture, efficiency, selectivity, injury, furbearers

The steel foothold trap is one of the primary and most versatile devices for capturing carnivores in North America [*1*]. Management objectives achieved by trapping include the commercial harvest of fur, trapping for recreation, reduction of wildlife populations for suppressing density-dependent zoonoses, resolving urban nuisance problems, and control of damage to agricultural crops and livestock. Both the public and natural resource agencies are thus impacted, and use of steel traps for the capture of wild carnivores is therefore an important wildlife management issue. Public opposition to the steel trap is increasing as society becomes increasingly urbanized, and restrictions on trapping by public referendum or legislative initiative threaten to reduce the management options available to resource agencies [*2*]. Some opposition to traps and trapping centers about foot injury and associated trauma sustained by captured animals and the accidental capture of nontarget species. Others oppose trapping because it is a consumptive use of wildlife. Trappers and government agencies using traps as a management tool are concerned about cost/benefits and trap efficiency and performance under varying environmental conditions.

Few standard test methods for evaluating and comparing commercially available or modified prototype foothold traps have been developed, nor have much data on trap performance been published. Thus, confrontation and dialogue between opposing and polarized groups are based largely on emotional rhetoric and testimonial-type statements rather than on conclusions drawn from systematic study and data analyses. Recent studies have sought to evaluate steel traps having padded jaws or pan tension devices and to compare their performance with standard traps. A few protocols for making these assessments have been devised, but results indicate a strong need for and the desirability of developing standard test methods. This paper selectively

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cites technical literature that will be helpful for designing trap test protocols and discusses specific criteria that should be considered with the eventual objectives of establishing standardized laboratory and field procedures to characterize and compare different types of steel foothold traps.

Once test objectives have been defined, including priorities and decisions on trap types, intended use, and species to be captured, the proprietary status of traps should be ascertained. It is essential to know if traps or portions thereof are patented, have a patent pending, or are considered to be in the public domain. It must also be determined if individuals or corporations desire confidentiality before agreeing to tests of their prototype or experimental traps. The availability of traps, whether they are commercially produced or experimental prototypes, their cost, and current or anticipated production are all important to determine before undertaking trap evaluation.

Descriptive Criteria for Traps

The physical characteristics of traps are a major component of trap performance and thus influence the physical and behavioral responses of target and nontarget animals. Descriptive factors characterizing foothold traps are as follows:

Trap Materials, Construction, and Components [3–8] (see Fig. 1)

1. *Material characteristics.* Describe and measure the type of steel and Rockwell hardness of various trap components as they affect performance. Nonmetallic components such as jaw pads of rubber or plastic, if present, should be described and hardness measured. Physical changes of materials, if any, under normal and extreme temperatures should be determined.
2. *Trap weight and jaw spread.* Determine trap weight and relate this measurement to jaw spread as a factor indicative of both durability and portability.
3. *Component replacement and tolerances.* Determine if replacement parts for traps are readily available, easily removed and replaced, and manufactured so that dimensional tolerances do not cause problems.
4. *Joining of components.* Describe how components are joined (that is, by rivets, welds, screws, or friction fittings) and the number, size, and location of joinings. Assess joining of components as they relate to structural integrity.
5. *Trap bottom and cross.* Detail the construction of the trap bottom and cross, both manner of joining and dimensions and how they may affect performance and trap life.

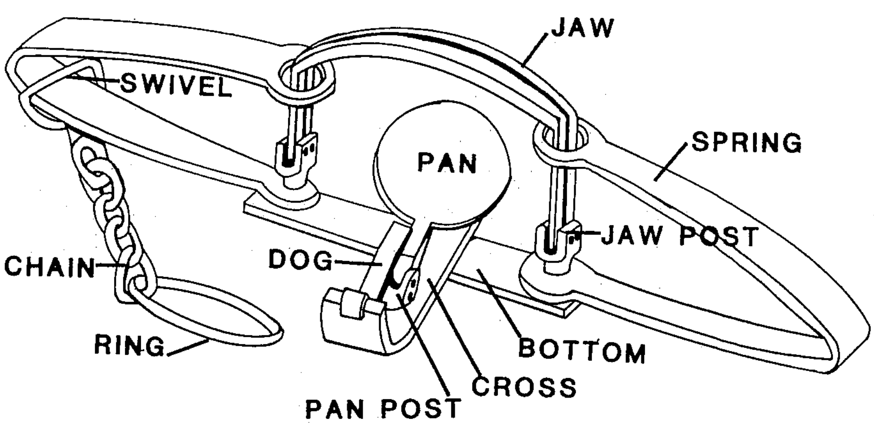

FIG. 1—*Parts of the steel foothold trap.*

6. *Springs.* Describe the type, number, size, location, and configuration of trap springs as critical components of performance.

7. *Jaws.* Note jaw configuration, mass, inner surface-bearing area, degree of off-set if present, and spread in open position. Note also whether jaws are stamped, coined, rounded, or cast and how jaw posts are constructed. Describe special jaw features such as padded jaws or jaws affixed with plastic sleeves to reduce foot damage or configurations to prevent wring-offs or chewing of the trapped foot.

8. *Pan and triggering mechanism.* Describe type and size of pan, pan notch, pan shank, trigger or "dog," and method of setting and triggering trap. Note distance of pan drop and extent of pan "wobble."

9. *Pan leveling and tensioning features.* Describe means of adjusting pan to level of trap jaws. Describe, if present, means of adjusting pan tension (for example, adjustable screw attaching pan post to trap cross).

Trap Accessories [6–11]

1. *Chain.* Note type (for example, kinkless), size, and length of chain as affixed to trap by trap manufacturer or as modified for field use. Describe any shock-absorbing devices affixed to chain.

2. *Swivels.* Describe type, size, number, and location of swivels on trap and trap chain.

3. *Anchoring mechanisms.* Describe how trap is, or will be, anchored in the field, noting size, length, and material used for stakes or drags. Note size, type, and number of prongs on drags. Describe special anchoring mechanisms such as deadman anchors, etc.

4. *Pan tension devices.* Describe pan tension devices affixed to trap or placed under pan at time of trap placement in field for excluding nontarget animals.

5. *Pan covers.* Note size and configuration, placement, and type of material used for pan covers.

Laboratory Tests

Evaluation of trap performance in the laboratory permits the taking of measurements that are difficult or impossible to obtain in the field. Sensitive and costly mechanical and electronic equipment can be used to measure various parameters of trap operation. Environmental factors influencing performance, such as soil type, soil moisture, and temperature extremes, can be simulated, measured, and incrementally altered and the data compared. Such tests are more accurate and can be conducted much more easily and at far less cost than is possible under field conditions. Optional use of animals confined in enclosures allows observations to be made of trap/animal interactions and behavioral responses to capture and restraint. Few standardized laboratory tests for foothold traps have as yet been devised but some developed in Canada for kill-type traps have applicability. The following parameters are feasible to measure in the laboratory once standardized test methods are devised:

Trap Preparation and Maintenance [6,11]

1. *Degreasing and cleaning.* Describe methods used to remove factory grease or oil from new traps and to clean used traps removed from the field as these procedures relate to animal detection of set traps.

2. *Trap surface preparation.* Evaluate various ways of preparing new traps prior to applying trap dye.

3. *Trap dyes.* Evaluate various trap dyes, comparing cost, ease of application, and durability.

4. *Protective coatings.* Test various waxes, coatings, and cold-galvanizing compounds for

protecting traps from oxidation and corrosion in fresh or brackish water and in wet or alkaline soils. Simulate effective field life of coatings.

Trap Mechanics [3,4,12–14]

1. *Spring kinetics.* Use standard engineering tests or devise new tests to measure the kinetic energy and momentum of springs as they relate to powering trap jaws. Relate these measurements to trap efficiency and potential injury sustained by captured animals. Obtain test data from traps set and sprung in a vise, in soils, and underwater.
2. *Spring fatigue.* Develop mechanical flex or compression and expansion tests to measure the rate of spring deterioration or failure over time.
3. *Holding or clamping force.* Determine means of measuring, holding or clamping force of traps as this factor relates to the frequency with which captured animals succeed in pulling free of sprung traps.
4. *Trap adjustment and repair.* Assess frequency of pan and pan tension adjustment required and causes and frequency of component failure due to metal fatigue and/or damage.

Trap Performance [4,14,19]

1. *Varied soil conditions.* Simulate commonly encountered field conditions by springing traps in different types of dry, crusted, wet, and frozen soils. Measure trap spring rates and foot pounds of pressure required to spring traps under these conditions.
2. *Underwater.* Compare spring rates of traps set and sprung underwater.
3. *Closure speed.* Determine speed at which traps close and relate closure speed to catch rates, particularly of species having fast response rates to threatening situations. Relate comparative closure speeds to trap efficiency.

Trap Tests with Captive Animals [4,9,16,17]

1. *Approach and response behavior.* Carry out direct or remote (TV) observations of animals approaching trap sets, and their behavioral responses when initially captured and for varied time periods thereafter. Correlate these data with trap efficiency, injury rates and causes of injury.
2. *Drowning sets.* Measure rapidity of death and associated physiological parameters using captive animals taken in various type traps, with drowning wires and with trap anchoring mechanisms.

Field Tests

Field tests of traps encompass a wide variety of factors, including test protocols, measurement of trap efficiency, and trap-related injury. Trapper performance, the behavior and ecology of target and nontarget species, and environmental conditions must be considered and will influence the outcome of field tests. While beyond the scope of this paper, social, economic, and political factors will also determine the types of field studies that will be undertaken. Depending on test objectives, funds, personnel, and time, some or all of the following factors should be described or measured:

Field Test Protocols [6,8–11,18–27]

1. *Field data collection.* Devise data sheets to record numerical data and descriptive information. Maximize easy transfer of data from field sheets to automatic data processing (ADP)

systems or other automated or statistical methods of analysis. Provide a completed sample field sheet to each field cooperator.

2. *Instructions.* Provide detailed oral and written instructions to field personnel before field trials are initiated.

3. *Specimen collection.* Determine in advance what specific tissue, organ, whole body collections, or live specimens are needed and the means of temporary and long-term preservation or restraint. Provide field personnel with preserving fluids, tags, bags, containers, coolers, cages, and/or instructions.

4. *Marking and labeling.* Determine in advance how traps, trap sites, and collected specimens will be flagged or marked along trap lines or for future reference. Ensure that duplication of numerical systems is avoided between and among field personnel and that a permanent marking procedure is used.

5. *Visual records.* Review need for photographic, time-lapse movie or videotape documentation. Ensure that field personnel are provided with information on type, number, and quality needed and that they are qualified to use recording equipment.

6. *Time of test.* Conduct field tests over a period of time sufficient to minimize animal avoidance of novel or frightening stimuli (neophobia). Depending upon objectives, limit length of test periods to avoid occurrence of seasonal changes in animal behavior, such as breeding and denning, while test is in progress. Replicate tests to assess if seasonal differences in results occur or, depending upon objectives, avoid seasons when target species are difficult to capture or when weather limits trapping success.

7. *Trap line location.* Locate trap lines where adequate numbers of target species (and nontargets if in protocol) are present. Avoid situations where humans, livestock, or nontarget wildlife interfere with data collection or where access is difficult or dependent upon moderate weather conditions. Conversely, if trap use will normally be under the above conditions, select test areas to measure the effect of these situations. Design tests such that the effect of each factor, or all factors in the aggregate, can be determined.

8. *Trap site selection.* Predetermine whether traps will be located at prescribed intervals, along roads, trails, or water bodies or shore lines, at random intervals, on sign or travel routes, along edge habitat, or as determined wholly by field personnel. Insofar as possible, ensure that all trap types are equally exposed to susceptible animals. Set equal numbers of each type of trap being tested. Determine distance between traps based upon species behavior, density, and movement patterns.

9. *Trap sets.* Use the same type of trap set (for example, dirt hole, scent post) or use equal numbers of each type of set for each trap type.

10. *Trap-setting methods.* Use the same type equipment (for example, pan covers, kneeling cloth) for all traps. Where feasible, have one individual set and test traps.

11. *Trap types.* Alternate trap types being tested along trap line or, for example, if three types are to be tested, alternate and set in series of three or set randomly in series of three. When setting along roads or track, set on alternate sides of road to minimize influence of prevailing winds. Consider length of trap line and numbers of traps as related to the ability of the trapper to check his line and record data in one working day, or on alternate days.

12. *Trap check intervals.* Check all traps daily and remove animals or check daily leaving animals restrained in traps to simulate longer legal requirements for inspecting traps. Consider tests of several different trap check intervals, or at trap check intervals considered normal, to ascertain differing levels of performance or injury to captured animals.

13. *Animal removal and trap relocation.* Determine procedure for removing and/or killing animals from traps and if traps should be relocated, depending upon species captured. Ensure consistent procedure for relocating all or a portion of trapline when animal catch diminishes or ceases.

14. *Odor attractants.* Determine if specific attractants (lures and baits) are to be provided and if their use will be required by field personnel or if their selection is optional. If preselected, ensure consistent quality and specify quantity to be used and where they are to be placed. Ensure similar use between trap types unless attractant evaluation is an objective of field test. If desired, specify urine types (that is, estrous, nonestrous, male), frequency of renewing at trap sites, and if and when alternate attractants can be applied.

15. *Visual attractants.* Ensure that use of visual attractants be consistent between trap types or that records be maintained as to their use.

16. *Sound attractants.* If electronic attractants (usually battery operated emitting prey-like distress cries) are used, the same type of sound, volume, and broadcast interval should be used. Maintain use records and instances of malfunction or battery failure.

Trap Efficiency [4,6,8,9–11,18,19,21,23–25,27–32]

1. *Sample sizes.* Determine criteria that will be used for comparing trap performance and efficiency. Consult with statistician to review procedures and estimate sample sizes required. When possible, use standard numbers of observations or sample sizes per "treatment."

2. *"Standard" trap designation.* Where feasible, designate a "standard" (that is, commonly used) commercially produced trap for which the parameters of performance outlined below will be measured. Using the same parameters, compare prototype, modified traps with differing components, or other types of traps, with the "standard."

3. *Trap setting.* Document the ease or difficulty of setting each type of trap under various environmental and edaphic conditions. Relate setting procedure to trap size, shape, chain and swivel locations, modifications or special features, and ease of "bedding" and concealment.

4. *Drowning sets.* Determine and compare the specific factors associated with drowning sets that ensure maximum catch, drowning, and selectivity rates.

5. *Animal activity at trap sets.* Using visual sign left by animals visiting each set, determine the animal species that visited the set, stepped on the trap pan but did not spring trap, sprung the trap but was not captured, was captured but pulled free, or that was captured.

6. *Captured animals.* Record the species captured in each trap, sex and age, if target or nontarget, whether alive, injured, or dead, and if released or killed. Note location of trap on foot (on toes, foot pads, above footpads).

7. *Selectivity.* Determine selectivity by comparing capture rates of target and nontarget species. Compare rates of selectivity with trap size and other physical trap characteristics, including use of pan tension devices. Relate selectivity with the ecology and behavior of species present in test area and with the location of traps in relation to habitat and population densities.

8. *Capture efficiency.* Ensure that all trap types being evaluated are set similarly, are equally exposed to target animals, and are checked at the same intervals. Express efficiency as the number of trap nights (one trap set and operating for one night) required to capture one animal.

9. *Causes of failure.* Note causes of trap malfunction due to weather such as failure to spring in frozen soil or mud. Check trap and components for frequency of breakage, bent parts, damage by captured animals, malfunctioning swivels, and component failure. If possible, document mean field life of trap before repair is required.

10. *Repair.* Note ease or difficulty of making repairs and trap adjustments under field conditions. Determine availability and cost of replacement parts.

11. *Comparison with other capture devices.* Devise protocols for comparing capture efficiency of foothold traps with live and kill-type traps and with body and leg snares. Compare cost, versatility, capture and injury rates, expertise required for use, selectivity, and suitability for various species.

Trap-Related Injuries [6,8,9,10,20,23–27,31,33–35]

1. *Injury by standard traps.* Determine extent of injury, if any, to captured animals, target and nontarget, caused by standard or commercially produced foothold traps. Obtain the same data for modified, experimental, or prototype traps and compare data sets.
2. *Trap-caused injuries.* Establish a numerical system, compatible with statistical procedures and analysis, to rank trap-caused injuries. Determine external and internal injuries to legs of captured animals as assessed by a veterinary pathologist or other qualified person.
3. *External injuries.* Determine and rank extent of edematous swelling, hemorrhage, and number and size of abrasions. Note number, location, length, width, and depth of cuts. Note partial or complete amputation of toes or foot.
4. *Internal injuries.* Determine by necropsy and radiography, number and severity of tendon and ligament lacerations, joint subluxations or luxations (dislocations), and compression, simple, or compound fractures above, at, or below carpus or tarsus.
5. *Indirect injuries.* Distinguish between injuries caused directly by trap jaws versus that sustained as a result of struggles to escape (for example, high fractures, abrasions, cuts, from trap chain, adjacent vegetation).
6. *Factors affecting extent of injury.* For each captured animal, record time in trap, trap type, location of trap on foot, and environmental factors that may influence injury.
7. *Long-term effects of capture.* Trap, affix radio transmitters, and release animals injured by capture. Record extent of injury upon initial capture and subsequently recover telemetered animals (by shooting) to determine physical condition after specific time periods have elapsed.
8. *Effects of chemicals.* Describe physical features and method of making trap tabs placed on jaw of trap to tranquilize or kill captured animals. Note chemical formulation and dosage in tabs. Observe trapped animals to determine their response to central nervous system depressants or toxicants. Relate extent of injury and physiological state to ingestion and dosage rates.
9. *Injury rates versus performance.* Compare extent of injury and capture rates of both standard and experimental traps. Determine if efforts to minimize trap injury affect trap performance.

Trapper Performance [6,18,20]

1. *Trapping experience.* Quantify or rank the level of experience of trappers with respect to trapping ability and knowledge of the specific trap types under study. Include trappers' ability and willingness to learn and adapt customary procedures to new or modified trap types. If possible, select trappers with professional competence.
2. *Animal biology.* Rank trappers with respect to knowledge and awareness of ecology and behavior of species of interest and ability to read "sign," determine travel routes, estimate abundance, and knowledge of other biological factors maximizing the potential for successful field tests.
3. *Geographic knowledge.* Determine extent of trapper knowledge regarding regional and local geography, access to test areas, and environmental and climatic factors as they relate to field trials.
4. *Research experience.* Determine trapper background and experience as regards conducting trap-related field research or other research activities, including personal bias, preconceived opinions, objectivity, understanding of concepts of randomness, sampling, and need for uniformity of methodology, etc.
5. *Supervision.* Determine whether trappers will be supervised or checked while collecting data and whether supervisors are knowledgeable about traps, trapping, and local conditions.
6. *Familiarity with procedures.* Assess the extent to which trappers are familiar with instructional material, field data forms, and methods of recording data. Ensure that questions regard-

ing procedures can be answered when needed and that test objectives and protocol do not conflict with trappers' personal convictions and self interests.

7. *Competence.* Establish that trappers selected for field evaluations have the ability and are willing to follow required procedures and record the desired data.

8. *Interviews.* Conduct pre- and post-field test interviews with trappers. Review procedures or problems encountered during tests. Obtain a written summary from trappers describing personal observations, conclusions, and recommendations.

Species Ecology, Behavior, and Population Parameters [6,9]

1. *Devise methodology.* Assess the relationship between the ecology, behavior, and abundance of species of interest and proposed test protocols.

2. *Population densities.* Assess qualitatively (or preferably index) population densities of species of interest on potential test sites prior to field tests to determine if levels of abundance are likely to yield desired sample sizes.

3. *Sex and age data.* Determine if test protocols are likely to reveal differential trap performance by age, size, or sex of species of interest. If adjudged important, conduct field tests in areas or at times of year to acquire sex and age data.

4. *Behavioral response.* Document behavioral responses of species visiting trap lines and trap sets. Note animal avoidance of certain traps, trap sets, sites, or preference for visiting certain areas with distinctive environmental or habitat features. Record specific behavioral activities such as rolling, digging, scratching, urinating at trap sets, and whether such activities vary seasonally or by sex or age.

Environmental Factors [9,18–20]

1. *Geographic and vegetative conditions.* Describe and rank in importance geographic factors such as topography and type and extent of vegetative cover in and around test areas. If possible, undertake geographically representative tests of traps to determine if efficiency varies significantly depending upon locale.

2. *Habitat.* Assess available habitat and quality thereof for target and nontarget species of interest, including availability of cover, water, and food. Note distribution patterns of species of interest in relation to location and prevalence of the above factors. Use these data to establish the location of test sites and relate test results to habitat parameters.

3. *Seasonal and geographic influences.* Determine advantages and disadvantages of conducting seasonal tests to measure differences in trap performance, selectivity, and capture rates. Conduct field tests in relation to anticipated seasonal needs or uses, or in conjunction with established trapping seasons. Consult with agencies and local trappers to determine where and under what conditions traps will be used. Design tests to reflect regional or local needs for specific trap types or trap uses.

4. *Edaphic factors.* Note type and prevalence of different soil types and soil moisture, and relate to trap performance.

5. *Climatic influence.* Record daily temperature means and ranges, barometric changes, atmospheric moisture, including snow, rain, freezing and subfreezing temperatures. Conduct tests representative of both "average" and extreme climatic conditions, the latter to represent marginal trapping conditions.

Discussion and Conclusions

Foothold traps have been used in North America since colonization: over 4000 patents have been issued in Canada and the United States for alternate trap types [*36*]. However, no standard procedures for either describing or testing and comparing trap performance have as yet been published. A high percent of the published studies comparing different type traps are limited in scope, use samples collected opportunistically, and lack a statistical basis for discriminating between trap types. More encouraging is the recent trend for wildlife biologists to solicit the assistance of specialists such as mechanical engineers, veterinary pathologists, and physiologists who are able to apply their training and knowledge to the complexities of evaluating traps and their effects upon captured animals. It is hoped that future research on foothold traps will follow the lead of the work on kill-type traps in Canada where broadly based support for research has led to sustained funding and the development of national test standards [*4,37,38*].

An estimated 750 000 people trapped and sold fur or earned livings from the fur industry, a billion-dollar economy in 1984 [*39,40*]. Trapping is also a source of recreation, a means of securing food for native peoples, and an important technique for regulating predators that caused an estimated 275 to $550 million loss to U.S. livestock producers and consumers in 1980 [*41*]. Traps are also used to take furbearers causing urban or rural nuisance or agricultural problems and to enhance survival of desirable wild species, including those endangered. Trapping is undertaken to locally reduce vectors of diseases such as rabies, and to conduct certain types of wildlife research. Despite these widespread uses, only very limited effort, either federal or state-supported, has been placed on a sustained effort to either systematically evaluate existing foothold traps or to modify them so as to increase selectivity, reduce injury to captured animals, or to enhance their performance. Establishing test methods is a first and logical step in this direction. In this regard, Deems and Pursley [*42*], referring to trap technology, stated, "Trapping system evaluations and research should include, but not be limited to, a scientifically and statistically designed methodology followed by field evaluation under a variety of environmental, political, sociological and economic conditions that exist domestically, as well as internationally."

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