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Review of progress in development and testing of humane animal traps

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Introduction

The role of the fur trade in Canadian history is legend. For the first century and a half after the founding of Canada our economy largely depended upon the harvest of furs of beaver, muskrat, foxes and other species. In those days there were no apologies for the methods of taking fur-bearing animals.

In Canada, this attitude continued well into the present century: only within the past couple of decades have questions arisen about harvesting methods. The main cause of concern for many people, trappers among them, is the development of humane trapping devices. They feel that in this period of advanced technology, there should be a painless method for taking fur-bearing animals.

On the surface the solution appears simple: test existing traps, ban those which are inhumane and invent new, more humane traps. Contrary to popular belief, however, setting standards of humaneness for traps and trap testing are complex and time-consuming procedures.

This report briefly discusses the involvement of the Canadian Wildlife Service (CWS) in the development and testing of humane animal traps. It also summarizes the results of research programs funded by the provincial and federal wildlife authorities.

Early efforts in the development of humane traps

CWS has been involved in the search for humane traps since 1956. At that time, in conjunction with the National Research Council (NRC), a number of prototypes of various quick-kill trap designs were built and evaluated. This early attempt to develop a humane trap was the result of the commitment of individuals within CWS and NRC. However, except for lands exclusively under the jurisdiction of the federal government, such as national parks, responsibility for the welfare and management of wildlife resources lies with the provincial and territorial governments. In an effort to foster co-operation in the development of humane traps, the CWS biologists displayed the NRC-produced traps at federal-provincial wildlife conferences – meetings of the federal, provincial and territorial wildlife managers – in 1956 and 1957.

In addition, Manitoba, Ontario, and British Columbia have been independently testing trap designs, and the Canadian Federation of Humane Societies through the Canadian Association for Humane Trapping has been instrumental in much of the progress made in humane trap development since 1957. In 1968, CAHT established a Humane Trap Development Committee. In 1970 this committee initiated the first scientifically directed laboratory testing of traps to establish the impact that must be delivered by the killing mechanisms on traps to humanely kill fur-bearers.

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Between 1970 and 1973 the Humane Trap Development Committee continued to sponsor laboratory research at McMaster University and the University of Guelph. That research was designed to provide threshold measurements of the force required to quickly kill representative fur-bearers so that trap manufacturers and designers could produce traps that would humanely kill animals and not merely immobilize or injure them.

Up to 1973 progress was not rapid for two main reasons. First, the work was of a pioneering nature, with all the problems attendant upon such work. Secondly, the work was done by university researchers who contributed their time largely on a volunteer basis and gave priority to other research. Also, funds were available only to cover out-of-pocket expenses.

A concentrated governmental program begun in 1973

The delegates to the 1973 Federal-Provincial Wildlife Conference established a committee to co-ordinate efforts to find and develop humane traps. The Federal-Provincial Committee for Humane Trapping (FPCHT) consists of representatives of the various provincial and territorial wildlife management agencies. The establishment of the FPCHT was a formal acknowledgement of the provincial governments' responsibilities for establishing regulations to make trapping humane.

Committee members faced a four-fold task: to begin compiling information on previous efforts of the provincial, territorial and federal wildlife departments; to review existing data on tests of humaneness of trap designs; to develop educational programs for trappers outlining optimum use of existing traps to minimize inhumane treatment of fur-bearers; to solicit new trap designs and to select trap designs for further testing. The committee recognized the need for rapid progress and gave itself 5 years from 1974 to accomplish its goal:

> Within a maximum of 5 years, to recommend to the provinces traps and trapping techniques for all fur-bearers which will, insofar as the state of the science or art will allow, provide the greatest 'humaneness' in holding or killing fur-bearers; and to maintain throughout the programme communication with governments, interested persons or groups and news media.

First the FPCHT had to become familiar with much of the groundwork done by the Humane Trap Development Committee. That done, the FPCHT worked to establish a solid base for the actual testing of animal traps. An essential and time-consuming early activity of the committee was to prepare patent procedures and safeguards to protect the proprietary rights of trap inventors, and to encourage them to share their ideas. In addition, the FPCHT made arrangements to deal with trap designs submitted as drawings and not as working models. If this happened, the FPCHT would have prototype models built to test the designs. However, the most important preliminary task was the formalization of rigid test procedures, both mechanical and biological, to assure comparability of results. This last activity has been one of the most time-consuming elements of the 5-year program.

'he role of CWS in the FPCHT

'WS provides accounting, financial and other administrative ser-ices for the FPCHT. CWS has also advised the FPCHT on iological questions. Since 1973 CWS has provided $80 838 owards the development of engineering test standards for evalua-ion and comparison of traps and towards detailed mechanical nd biological testing of seven trap designs to determine their umaneness. In addition, $35 000 has been provided directly to he committee in order that it may continue with its trap testing rogram.

CWS, as a result of its previous initiatives in testing animal traps, s commitment to the development of humane animal traps and s available resources, was given the role of designing and con-racting out the laboratory trap-testing work.

rogress of the trap-testing program

he initial stage of the trap-testing program was largely a learning rocess for both the program developers and laboratory researchers. tep one was to select a sample animal trap and subject it to a inge of mechanical tests.

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1 1974 the CWS contracted the Canadian Standards Association CSA), an acknowledged expert organization for the testing of onsumer products, to undertake a series of tests on the Conibear nimal trap. This particular trap was selected because of its com-iercial availability and its general acceptance as the most humane ap in use at that time.

Preliminary work included testing resistance to corrosion by sing a salt spray chamber and by immersing the trap in water hose pH (acidity or alkalinity levels) duplicated that of a typical outhern Ontario swamp; electronically recording the striking force f the spring-loaded trap arms on a "dummy"; looking for any ear or loss of effectiveness of trap components such as the trigger iechanism, the springs propelling the killing bars and the killing ars themselves; and measuring the forces required to cock the trap iechanisms and to trip the triggering mechanism.

Much was learned as a result of these tests. Although incon-usive test results often were due to physical trap failure rather ian procedural error, some refinements in the laboratory test pro-edures were indicated. For example, although the traps subjected the salt spray did demonstrate a high level of corrosion, the PCHT decided that this test was not really required: the results f immersing the trap in a water solution resembling the environ-ent in which it would be used were more suitable. In addition, ie test results led to the fundamental question of whether the trap eeded to be corrosion-resistant in the first place, and if so, to what egree. This question is not yet resolved.

In the early tests, CSA experimenters measured the actual force f the bars upon impact with a dummy, which contained electronic quipment designed to measure force. However, it became obvious iat striking force could be measured by simply determining the celeration of the striking bars from release to impact. This pro-edure was much simpler and required less electronic equipment hile at the same time no test animal would be required for the rictly mechanical testing, although live animals would be required r biological testing in the laboratory for some time to come. eld testing of traps judged humane in the laboratory would ways require the use of live animals.

1975

CWS contracted researchers at the Ontario Veterinary College (OVC), University of Guelph, to develop stringent and repeatable procedures for the biological testing program. The research team organized a preliminary live animal testing program whose primary objective was to carefully observe and analyze every step of their laboratory procedures. Once into a real program there would have to be exacting control of many factors. Test animals would have to be positioned so that the trap mechanisms struck the animals exactly on one of four parts of the body: head, neck, thorax (chest) or abdomen. A procedure would be needed to determine the exact cause of death of test animals. The allowable delay between injection with anaesthetic and testing of individual animals had to be determined. The positioning and fastening of electrodes to record vital signs would also have to be consistent. How long testers should continue to record the vital signs of the animal after impact would also have to be specified. Although medical experts could provide some insight into the physiology of human death, there had never before been any need to analyze the physiology of animal death.

The research team at OVC provided a list of procedures for subjecting animals to trap testing. The team also defined humane laboratory death as a loss of electroencephalogram activity (brain death) of an anaesthetized animal within 10 min of receiving a blow from the trap mechanism. The specification of an anaesthe-tized animal was essential. While searching for and testing trapping devices for their "humaneness", it was necessary to protect labo-ratory animals from inhumane treatment in test programs, as well as to remove, in part, the variability in behaviour of each individual animal.

1976

(a) Testing by the CSA

In February 1976 the CSA began an extensive trap testing program. A technical committee of the FPCHT, consisting of two biologists, a mechanical engineer and a representative from the Canadian Asso-ciation of Humane Trapping had reviewed numerous trap designs and selected seven for laboratory mechanical testing. Three of these designs were immediately built as prototypes (10 of each de-sign) and submitted to the CSA for testing. In June, five samples each of four commercial traps were submitted to the CSA. Based on experience gained from preliminary tests on the Conibear trap, the CSA selected the following test parameters:

(1) striking force of trap on two sizes of dummies;

(2) cocking force required to set the safety catch and the triggering mechanism;

(3) force required to release the trigger mechanism at the full set position;

(4) deterioration in spring load after 500 cycles at the full set position;

(5) time required for the trap to close once the triggering me-chanism is released;

(6) physical weaknesses of the trap after 100 closures on dum-my bodies;

(7) resistance to corrosion when immersed in a water solution of pH 5.0-6.0 (approximately that of a natural swamp).

During this series of tests the researchers were faced with a variety of trap configurations and striking mechanisms. Some traps used sliding bars; others killed using swinging arms. This diversity made it necessary to change test procedures and use new electronic measuring devices to record such factors as the striking force and acceleration of the striking mechanisms. Even so, at the conclusion of testing, the researchers reported that with the funds available it was not possible to directly compare traps due to the variation in size and "killing" mechanisms. Another time-consuming problem was that the testing to determine spring durability and wear after repeated closures had to be done manually as there was no auto-mated apparatus which could set the traps.

This research revealed no major faults in construction of any design; each withstood repeated use without loss of performance, except that the killing bars on some traps bent significantly. Use of different construction materials could correct this problem.

Generally the more a trapped animal moved after impact the stronger the holding force became. This was caused by the trap springs moving along the jaws when the trap was vibrated.

(b) Cause-of-death research at OVC

In 1976 the OVC was awarded a second contract to continue biological evaluations of certain traps. In particular, the researchers undertook extensive post-mortem observations on test animals to try to determine the exact cause of death. Depending on the trap design and size of the animal, the killing mechanism can strike a range of body parts including the head, neck, thorax and abdomen. The team chose to evaluate three trap designs using two species of animals, which they selected based on the trap's size and its most likely target species. One of the trap designs was intended for small fur-bearing animals and the other two were intended for small and medium-sized fur-bearers.

Live animals were used for the biological tests to determine whether the traps were capable of killing them humanely.

Again the researchers defined humane death as "brain death" of an anaesthetized animal within 10 min from the time of impact. If the animals did not die within the 10-min test period they were killed using an intracardiac injection of a barbituric acid product.

Not unexpectedly the researchers found that the three trap designs were much more effective in causing a humane death when the test animals were struck directly on the head. Although autop-sies and X-rays did not reveal exact causes of death, death was no doubt due to massive head injuries. One of the traps was not effect-ive in killing groundhogs, larger fur-bearing animals, by striking them on the head. Only one in five groundhogs used to test the trap succumbed within the 10-min period. The remaining four groundhogs were killed after 10 min to ensure that they were not exposed to needless suffering. Autopsies on the four groundhogs which had survived the test showed that they had suffered minimal damage. All three traps were 100% successful at "humanely" killing representative small fur-bearers (e.g. mink) by head hits. Two of the three traps also killed 100% of larger fur-bearers (e.g. ground-hogs and muskrats) subjected to head hits.

The three trap designs were less effective, however, in humanely killing test animals struck in the neck, thorax or abdomen. In tests involving strikes to the neck the traps' effectiveness ranged from humanely killing (i.e. causing death within 10 min) 100% to killing only 20% of the test animals. In cases where death was not caused by the traps, autopsies revealed bone fractures and other injuries. Somewhat better results were observed when test animals were struck in the thorax region where vital organs, such as the heart and lungs, are contained. Although the researchers noted some fractured ribs in test animals, the chief cause of death of those animals which succumbed within the first 10 min was damage to the heart and lungs. None of the three traps was 100% effective for both small and large animals. The two traps tested for abdominal hits (one trap was designed to render abdominal hits unlikely) yielded poor results; no test animals succumbed within 10 min. Autopsies showed a large number of individuals had received organ damage which could have eventually led to death, but such deaths could not have been classed as humane.

To judge the "killing" potential of the traps, the researchers studied four sets of data:

(1) The kinetic energy possessed by the striking bar and the fraction of this kinetic energy transferred to the animal.

(2) The force exerted on the animal by the striking bar or bars during impact This is a function of the deceleration of the killing bar which in turn depends on the rigidity of the animal at the point of impact.

(3) The velocity of the striking bar at impact.

(4) The holding or clamping force exerted by the trap on the animal after the trap has come to rest.

The researchers gathered data on the acceleration of the killing bar from the moment of release from the triggering mechanism to its deceleration at impact. They hoped that by collecting this data they could produce mathematical models that would enable them to analyze trap designs in terms of their potential killing power (largely a function of spring power) and remove the need for using live animals for each series of biological tests.

The researchers were careful to report in their research results that their work necessarily only simulated actual trapping condi-tions, because of the need for repeatable, measureable and humane procedures. For instance, the animals were all anaesthetized and placed in traps so that they were struck at specific body locations. The researchers also observed that the traps generally caused little pelt damage. From a trapper's point of view this would be a plus for the traps.

(c) Experiments involving threshold force and construction of animal dummies

Another extensive 2-year research program at Ontario Agricultural College (OAC), University of Guelph was begun in 1976. This new program was primarily to carry on with the task of ascertaining the lower limits of force required for a trap to humanely kill a live animal. A second objective was to design, build and test animal dummies, whose physical properties closely resembled those rep-resentative fur-bearers, which could be used in biological test programs in place of live animals. During the course of the research, however, it became evident that dummies were not essential for trap evaluation. Sufficient data could be produced by measuring, first, the acceleration of the trap's killing member and, second, the clamping force of these same components on a simple testing block with the physical dimensions of a target animal. Consequently, by mutual agreement, the production of animal dummies was dropped from the contract.

The OAC team built a special trap simulator, somewhat resem-bling a guillotine controlled by a hydraulic cylinder and piston, to deliver carefully controlled blows to test animals to establish a threshold of striking force below which humane death did not occur. The simulator could be modified so as to alter the accelera-tion and velocity of the killing member, the mass (weight) of the killing member, and the force exerted by the killing member on the animal after impact. In addition, the simulator included electronic measuring devices to record the various measurable parameters. During the course of the research, tests were conducted on animals as small as muskrat and mink and as large as beaver and raccoon. To further the work previously undertaken, the test animals received blows to four parts of the body – head, neck, thorax and abdomen – to determine if the thresholds of impact force required to cause a humane death were different at these different locations. As in previous research, X-rays and autopsies were done on all test animals (including those that were not humanely killed by the trap simulator) to ascertain the cause of death.

The research program was able to verify that the velocity at impact and the effective mass of the moving part of the killing mechanism are the two important parameters for quantifying the severity of an impact. Momentum was found to be the best single parameter combining the velocity and effective mass.

It was not possible to establish a single impact threshold for a species because the live animals tested had different weights and physical conditioning. It was, however, possible to establish a threshold range between two extreme values. The upper value is that above which no animal survived in the tests and the lower value below which no animal died within the test period. The average of the upper and the lower values was called the mean threshold.

The OAC test program reached the following general conclusions:

(1) The mean threshold increases with animal size. Muskrat have the lowest mean thresholds and mean thresholds increase for mink, raccoon and are highest for beaver.

(2) The mean threshold, in the absence of a holding force, is lowest for head hits and highest for abdomen hits; usually the sequence was found to be head, neck, thorax and abdomen.

(3) It was not possible to establish mean threshold values for raccoon and beaver abdomen hits because of limitations of the testing equipment. In any case these lower threshold values are higher than the blows obtainable with traps available commercially in 1977.

(4) The data obtained from experiments with holding force were confusing. At the outset the researchers assumed that a holding force applied to an animal subsequent to an impact would aid in the killing process and they designed the experiments to determine just how much the impact threshold would be reduced by the application of a specific holding force. The results did not bear out the initial assumption. In some cases the holding force did reduce the mean threshold value and, indeed, was itself enough to kill the animal. But in others a very high holding force did not lower the mean threshold values. For example, mink have a large group of neck muscles on either side of the trachea and when they were struck on the neck this muscle mass was able to withstand the pressure of the striking bar and prevent them from being suffocated.

Limited data do suggest, however, that it may be possible for a trap to exert a holding force that will kill humanely. That is, at some level, a holding force applied in the absence of a blow will kill rapidly enough to be considered humane. The present research yielded only the threshold value for a blow in the absence of a holding force. It was impossible, with the available data, to determine a threshold value for a holding force.

(5) Rounded striking bars (which present less surface area) are superior to flat striking bars in that higher impact values result.

(6) Limited results from tests which involved altering the mass of the striking bar indicated that an increase in mass improves its killing ability.

Bearing in mind that field tests will have to be carried out to confirm the laboratory results, the preceding research allows the following conclusions about the construction of humane traps:

(1) Humane traps should be constructed or set in such a way as to promote hits to the head and neck, the most vulnerable body regions. Care should be taken to avoid abdomen hits.

(2) Mean impact thresholds (striking bar mass x velocity of striking bar) can be specified for the humane trapping of the four species tested: mink, muskrat, beaver and raccoon. Multiplying the determined mean threshold by a safety factor of 1.5 will assume that the striking force of a trap is great enough to humanely kill any animal.

There is a scientific basis for including a safety factor in the evaluation procedure. Theoretically a mean threshold of death should be a single number for each species. But in reality the fact that animals of the same species have a wide range of masses and vary in strength means that they have varying abilities to withstand the onslaught of a trap.

Also the killing bar of the trap simulator used in the laboratory tests to determine mean thresholds was a very rigid one compared to those of many of the prototype traps being tested. A rigid killing bar delivers a greater impact than a less rigid one because there is no loss of energy resulting from bending of the killing bars. The difficulty of calculating this loss of energy was another argument in favour of applying a safety factor.

In the case of trap testing no historical data were available to help researchers decide on an appropriate safety factor. They estimated 1.5 because the extreme threshold values generally vary very little (typically 10–20%) from the mean threshold value for each species. Thus a 50% increase (i.e. safety factor of 1.5) in calculated threshold impact values should assure that any trap kills humanely.

Summary of research findings

The FPCHT is nearing the end of its 5-year mandate. The extensive research program has produced an initial laboratory trap evaluation procedure to ascertain whether traps can kill humanely. This laboratory procedure does not involve tests on live animals. The kinetic properties of the killing bars of traps are evaluated mechanically and compared with established mean impact threshold values required to kill specific target animals (mink, muskrat, beaver and raccoon) by striking them on one of the four main areas of the body (head, neck, thorax and abdomen) for which impact thresholds have been calculated. (Abdomen mean threshold values for beaver and raccoon are not available due to test apparatus limitations.) Test traps whose killing bars exceed the mean impact thresholds of target animals can be considered to satisfy the laboratory definition of a humane trap.

The mean impact thresholds are useful to trap designers and manufacturers, who now have specific minimum performance criteria to apply in the production of animal traps.

However, the research to date also indicates that the holding force exerted by the killing bar contributes to the death of an animal in the trap. Mean holding force thresholds, distinct from the mean momentum thresholds, may "humanely" kill test animals. But current research data are not sufficient to calculate these thresholds.

The FPCHT has to date (early 1978) received 233 trap designs from inventors. There has been extensive laboratory testing on seven of these designs. Of these seven, three traps have been tested to the point of determining the momentum of their killing bars. So far not one prototype has produced the impact required to cause humane death to the range of animals likely to be taken in the field. A technical committee of the FPCHT reviewed the balance of the 233 trap designs and found them even less acceptable than the seven chosen for the preliminary testing.

Where to from here?

There has been significant progress, in the last 5 years, in determining how to evaluate the humaneness of animal traps in a laboratory setting. This has been done by examining the causes of death of animals subjected to a trap simulator and by testing the impact and holding force delivered by trap prototypes or available commercial models.

Although the laboratory tests sponsored by the CWS have given us a preliminary procedure for evaluating whether a trap is humane, field tests must be undertaken to verify that the laboratory conclusions are valid. To date, three models are undergoing field testing; the results are not yet available.

The FPCHT is still actively soliciting new trap designs and continuing with the laboratory testing of the best of the new designs as selected by the technical committee. Fifteen additional devices underwent mechanical testing during 1977 at the University of Guelph, using the testing procedures developed by previous research.

Results show that a trap should be designed to avoid impacts in the abdominal region if it is to kill humanely. Consequently the FPCHT is undertaking research on the optimization of placement of trap triggering mechanisms so as to prevent abdominal hits and increase head and neck hits.

In another new development, a committee under the Standards and Specifications Branch of the federal Department of Supply and Services is charged with writing the mechanical and biological standards for the evaluation of humane traps in the laboratory. First they will assess the testing criteria and procedures utilized to date. The final product will be the setting of national standards for the evaluation of humane traps. These standards will be statements of rigid research procedures to be employed whenever trap designs are to be assessed. When these standards are implemented, any research organization will be able to undertake trap testing and produce universally acceptable results which will be comparable to all past research. Designers and inventors likewise will have guidelines for construction of new traps. These standards will be used to regulate permissible traps on lands under CWS management. With the co-operation of the FPCHT, it is hoped that the standards will be adopted by all provinces and territories across Canada.