CANADIAN WILDLIFE BIOLOGY & MANAGEMENT

CWBM 2024: Volume 13, Number 1

ISSN: 1929–3100

Review

Best Management Practices for Furbearer Trapping Derived from Poor and Misleading Science

Naomi X. LOUCHOUARN[1], Gilbert PROULX[2], Thomas L. SERFASS[3], Carter C. NIEMEYER[4], and Adrian TREVES[1]

[1]Nelson Institute for Environmental Studies, University of Wisconsin-Madison, Madison, Wisconsin, USA. Email: louchouarn@wisc.edu

[2]Alpha Wildlife Research & Management Ltd, Sherwood Park, Alberta, T8H 1W3, Canada.

[3]Department of Biology and Natural Resources, Frostburg State University, Frostburg, Maryland 21532, USA.

[4]Retired expert US Government trapper, https://www.carterniemeyer.com/bio

Abstract

Given a shift in public opinion in the European Union (E.U.), the United States of America (U.S.), Canada and Russia developed standards (International Organization for Standardization, ISO, standards) to increase humaneness in trapping. However, concern for maintaining the viability of the fur industry and management of furbearing animals dependent on trapping undoubtedly catalyzed the development of a Best Management Practices (BMP) initiative to identify and compare traps and trapping techniques. Given the push for the development of BMPs, White *et al.* (2021) set out to develop recommendations as what they termed BMPs for trapping of "furbearers" in North America to meet agreed upon guidelines. That study is one of the few analyses comparing and evaluating restraining, primary foothold (leghold), trap devices across multiple species. As such, it has been used to justify and promote trapping and to develop trapper education courses in the US and abroad. In this evaluation of White *et al.* (2021), we demonstrate that 1) trap assessments did not properly use ISO standards and definitions of trap evaluation metrics, and failed to implement the most recent standards accepted by the U.S., and 2) researchers followed a research protocol that was incomplete, inadequate, and non-replicable. When sound policy depends on a solid base of evidence, then too science should be held to the highest standards of the open science movement that prioritizes transparency, reproducibility, and research integrity. We conclude that White *et al.*'s (2021) study should be redone with a comprehensive, standardized approach and new parameters to arrive at better best management practices for capturing furbearers.

Correspondence: Naomi X. Louchouarn, Nelson Institute for Environmental Studies, University of Wisconsin-Madison, Madison, Wisconsin, USA. Email: louchouarn@wisc.edu

Key Words: AIHTS Standards, Best Management Practices, BMP, Capture Efficiency, Furbearer, Humaneness, Furbearer Trapping Standards, ISO Standards, Reproducibility, Research integrity, Selectivity, Trapping.

Introduction

Government policies that permit restraint or killing of wild animals exemplify the science-policy interface in which policy is defined both by values and by scientific evidence describing past, present, and potential futures of wildlife and human interactions. Since the early 1900s, organized anti-trapping and anti-leghold trap campaigns relentlessly pushed against wildlife conservation and management programs involving mammal trapping (Proulx and Barrett 1989). As a result, and because of widespread European concerns, the International Organization for Standardization (ISO), through Technical Committee 191, re-evaluated mammal trapping across the United States of America (U.S.), Russia, Canada, and the European Union (E.U.), and laid out standards to improve humaneness of any mechanically powered traps used to restrain or kill animals (Proulx *et al.* 2020). Also, under the pressure of the European Community to ban the importation of fur products from animals captured with steel-jawed leghold traps, negotiations between fur-producing countries began toward an Agreement on International Humane Trapping Standards (AIHTS) that would result in the development of trap assessment protocols (Proulx *et al.* 2020). These standards were agreed upon and signed by Canada, Russia and the European Community in 1997 (Proulx *et al.* 2020). The U.S. did not sign the AIHTS, but participated through an Agreed Minute, a non-binding diplomatic agreement, which nearly replicated the AIHTS guidelines (Agreed Minute 1998). However, these standards are not necessarily representative of state-of-the-art trapping technology, and their inability to properly assess trapping devices have repeatedly been pointed out by wildlife professionals (Powell and Proulx 2003; Iossa *et al.* 2007; Proulx *et al.* 2020; Conejero *et al.* 2022; Serfass 2022). Inadequate trap testing for animal welfare (Caravaggi *et al.* 2021) and selectivity (Virgós *et al.* 2016), the use of non-replicable trap assessment methodology (Caravaggi *et al.* 2021), and the continued use of steel-jawed leghold traps (Feldstein and Proulx 2022), killing neck snares (Proulx *et al.* 2015) and other trapping devices that are known to cause prolonged pain and suffering (Proulx *et al.* 2012) are examples of why, to be acceptable, trap assessments should be based on properly designed, implemented, and critically evaluated scientific methodologies.

The concern for maintaining the viability of the fur industry and other approaches for managing furbearing animals dependent on trapping undoubtedly catalyzed the development of a Best Management Practices (BMP) initiative as a basis to assess traps and trapping techniques. The Wildlife Society Technical Review 90-1 (Boggess *et al.* 1990) serves to advocate trapping; identifies concerns about adverse consequences the "anti-trapping" movement could have on the perpetuation of trapping; establishes the virtues of trapping (e.g., social, economic, and research values); and identifies approaches to enhance the perception of trapping through public education. A subsequent publication in the Wildlife Society Bulletin (Batcheller *et al.* 2000) mirrors many of the concerns established by Boggess *et al.* (1990) about the potential loss of trapping as a viable aspect of wildlife management and has essentially served as an action plan for the promotion of trapping by listing 12 focal areas that should be addressed as a basis for maintaining the integrity of the furbearer management system in the United States. The first focal area is the development and implementation of BMPs for trapping. The document emphasizes the importance of educational outreach and associated messaging in promoting the virtues of trapping both internally (i.e., a focus on wildlife professionals and policymakers associated with the US wildlife management system) and to the public.

White *et al.* (2015) portray various benefits of "regulated" trapping and establish that "*Steps have been taken by wildlife professionals to improve the humaneness of trapping through the development of international standards used to evaluate traps.*" (i.e., through the BMP process). The Conservation Brief "Regulated Trapping and the North American Model of Wildlife Conservation" (Association of Fish and Wildlife Agencies [AFWA] Undated a), establishes trapping as fitting the North American Model of Wildlife Conservation (see Serfass and Proulx 2024 for a contrary position), contrasts regulated versus unregulated trapping, and connects science to the BMP process. The Northeast Furbearer Resources Technical Committee published a document about trapping apparently intended at least in part for a non-professional audience ("Trapping and Furbearer Management in North American Wildlife Conservation"; Organ *et al.* 2015), which espouses various societal and wildlife management benefits derived from trapping and advances in the humaneness of trapping propagated by the BMP process. The portion of the AFWA website devoted to trapping likewise contains an extensive review of educational initiatives, messaging for public relations, social-science-based assessments, and traditional research associated with trapping wildlife, including an extensive, updated review of BMPs (see https://www.fishwildlife.org/afwa-inspires/furbearer-management).

Given the push for the development of BMPs, White *et al.* (2021) set out to develop recommendations as BMPs for trapping of "furbearers" in North America to meet the guidelines in the Agreed Minute (1998). That study is one of the few analyses comparing and evaluating restraining trap devices across multiple species. As such, it has been used to justify and promote trapping and to develop trapper education courses in the US and abroad. In fact, 12 of the 14 authors on White *et al.* (2021) are employees of agencies that are members of the AFWA and therefore associated, either directly through the Furbearer Conservation Technical Working Group (at least 2 authors on White *et al.* 2021) or indirectly, with the promotion of trapping. The fish and wildlife agencies represented by AFWA have specific goals of promoting trapping and its supposed benefits, yet we expect their research on the impacts of trapping on wildlife to be transparent, reproducible and unbiased. The close association of promotional aspects of trapping with wildlife professionals and the evolution of BMPs, should raise concern about the objectivity among those engaged in the BMP process. In this evaluation of White *et al.* (2021)'s BMPs for restraining mammals using traps, we demonstrate that 1) trap assessments, particularly in the way these authors assessed humaneness, efficiency and selectivity, did not properly use ISO standards and failed to implement the most recent AIHTS standards accepted by the US, and 2) researchers followed a research protocol that was incomplete, inadequate, and non-replicable. The most accurate and useful BMPs should ideally represent protocols which are based upon the best scientific evaluations. In this case the authors have attempted to develop BMPs by testing traps using ISO guidelines as a baseline, but they have fundamentally fallen short because they did not appropriately define trap evaluation metrics and did not design a transparent, reproducible experiment.

Evaluation of White *et al.* (2021)

Methodological constraints of the study design

White *et al.* (2021) evaluated 84 models of restraining traps across 33 U.S. states between 1997–2018 to determine how well they performed by 3 primary criteria: (1) animal welfare, (2) capture efficiency, and (3) selectivity. While these criteria are defined in the ISO guidelines, which White *et al.* (2021) ostensibly used to establish their BMPs, the ISO guidelines were not released until 1999, 2 yrs after the beginning of White *et al.* (2021)'s study. According to White *et al.* (2021)'s supplemental materials, of the 84 trap types tested, 10.7% (n = 9) were tested in 1998, before the release of the ISO standards, though many of these were tested again after the release of ISO standards. Perhaps more concerning, however, is some trap types were only tested on 4 species (coyotes *Canis latrans*, northern raccoons *Procyon lotor*, red foxes *Vulpes vulpes*, and North American opossums *Didelphis virginiana*) before the release of the ISO standards. This suggests that White *et al.* (2021) may have begun their study by following the standards laid out in the Agreed Minute (which were based on AIHTS) and then changed their standards once ISO was released. Further, we find significant discrepancies in how the authors defined their guidelines or developed their study designs. Specifically, these discrepancies are related to failure of approaches followed by White *et al.* (2021) to align with the ISO and/or Agreed Minute (i.e., AIHTS) definitions or recommended trap evaluation methods (Table 1).

One discrepancy at the outset is that the ISO defines traps being evaluated as being included in a trapping system. A restraining trap device can be installed in numerous ways under diverse conditions. A trapping system is more than just the device and includes: 1) the trap device, with its many specific characteristics (i.e., dimensions, shape, power, and attachments); 2) a trigger with a specific shape and operation; and 3) a set with a specific placement of the trap, and bait or lure (Figure 1a; Pawlina and Proulx 1999). How traps are set can differ widely and has been shown to have different outcomes on trap humaneness, efficiency, and selectivity (Pawlina and Proulx 1999; Caravaggi *et al.* 2021; De Ruyver *et al.* 2023). Figure 1(b-d) shows the same trap device being used in 3 different systems. Mammal trapping standards should refer to trapping systems, and not just individual trap devices. Furthermore, from the perspective of reproducibility, if the trap system results in differing outcomes, trap devices cannot be compared without a standardized trapping system (Pawlina and Proulx1999). Indeed, the same trap device in a different system cannot be compared. White *et al.* (2021) did not specify which system they used, though they did specify if they set traps on land, nor did they standardize systems between sets, therefore we assume they allowed trappers to choose their preferred system. Standardizing a trapping system is the only reproducible way to uniformly test a trap across the country, as these authors wanted to do. Without standards and control over variation in systems, comparing between trap devices risks confusing the system with the device.

Relatedly, there are numerous variables involved in trapper behaviour and system set up, let alone ecological conditions, leading to nearly infinite variations in micro-site, trapper practice, and response of target and non-target animals (Pawlina and Proulx 1999; Responsive Management, 2015).

Table 1. A comparison of White *et al.*'s (2021) methodology and the ISO and/or AIHTS requirements they claim to follow. We include suggested alternative approaches we argue are better supported by the literature, and would result in more robust and reproducible results.

White *et al.*'s (2021) method	Suggested alternative	ISO and/or AIHTS requirements
Testing trap types.	Testing trapping systems– standardization of set and trap type.	Testing traps within trap systems.
Unclear sampling effort: 10, 14 or 21 days (page 15). Minimum of 4 traps (page 14), non-standardized across trap types, species, cover type.	Standardized sampling effort with clear reporting of sampling time, number of traps, sample location selection, technician training.	Enough traps to ensure statistical power, traps should be paired with control traps and vegetation, substrate and trap system should be standardized.
Capture efficiency defined as number of individuals captured divided by number potentially captured (page 16). Relies on potentially biased interpretation of 'potential captures'.	Use the scientifically supported definition of efficiency based on number of captures per trap-period which accounts for sampling effort and time. Only relies on actual captures.	Capture efficiency is defined as "capability of the trap, as part of a trapping system, to capture target animals within a specified time period" (ISO, page 1).
Animal welfare scoring only included injury, and excluded self-inflicted wounds and 'external' deaths (i.e., determined non-trap related).	Liberalize the definition of 'trap-related' to be more precautionary, thereby including internal injuries from over exertion, self-inflicted injuries, and deaths that are a result of restraint, leading to drowning, hypo- or hyperthermia and/or attack by external individuals.	AIHTS specifies that behaviour be considered as a welfare metric, and that behavioural indicators of poor welfare include self-inflicted wounds and unresponsiveness. AIHTS also defines restraining traps as traps that keep animals alive until trappers can make contact with them. It does not make exceptions for 'external' causes of death. ISO also does not distinguish between causes of death for an animal in a trap. ISO requirements only state '*describe all injuries that can be related to the trap/trapping system'* (ISO, page 5).
Animal welfare scoring for a trap type based on average welfare score.	Using a one-tail binomial distribution to determine the probability that traps will be successful and humane $\geq$70% of the time as per Proulx *et al.* (2020).	80% of animals must have a welfare score <50 points.
Selectivity defined as all captured furbearers divided by total captures of all species.	Use a selectivity index, such as Savage's W: capture proportion of target species/population proportion of target species. Capture proportion is ISO's definition of selectivity, divided by a known proportion of target species.	ISO defines selectivity as "*number of captured target animals divided by the total number of captured animals"* (ISO page 2).

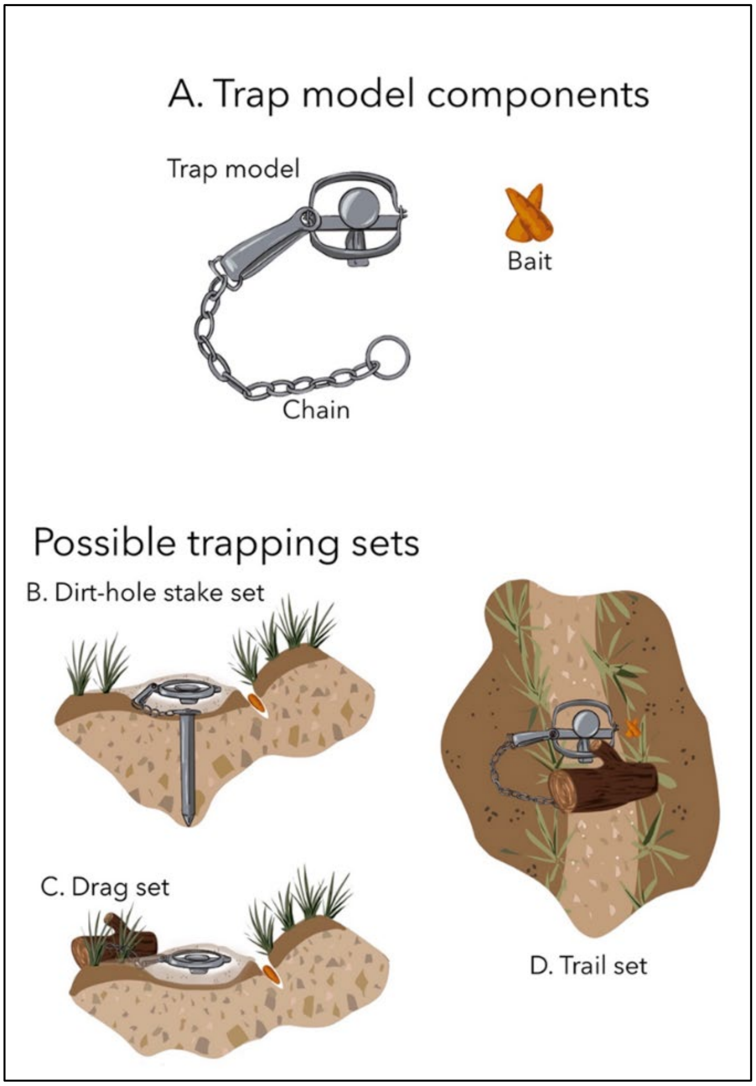


Figure 1. Example of various canid trapping systems using the same (A) trap model, chains, and bait; B – a dirt-hole set; C – a drag set; and D – a trail set. The dirt-hole set (B) consists of a trap attached with a short chain to a stake located immediately underneath the trap. The trap is covered with sifted soil. The bait is covered in a hole. The same baited hole can be used with a drag set (C) where the trap is affixed to a long chain and a log. A stake or a drag set can be used on a trail set (D). If the chain used in these sets is equipped with swivels and a shock absorber, the risks of injuring the captured limb is lower. If the chain used in the drag set is short, the captured animal may get injured while pulling on the chain. Injuries to a Canada lynx (*Lynx canadensis*) captured in a stake set will be less likely to be severe than in a drag set where the chain may become entangled with vegetation and the animal may break a leg. A dirt-hole set (B) is more selective than a trail set (D), which can capture different species of furbearers moving through an area. In all sets, if the bait is not properly covered, birds of prey may be captured. Because the trap device will impact differently on captured animals, each trapping set needs to be tested independently from each other. Results obtained for a trap device in one trap set cannot be pooled with those of another trapping system.

The authors conducted their study in various undescribed vegetation cover types with different weather and soil conditions (White *et al.* 2021, page 11). They also did not appear to standardize trap preparation, which can affect the appearance and therefore capture rate of particular species (Proulx *et al.* 2022a). Further, for humaneness evaluations, trap check intervals should be standardized. While White *et al.* (2021) required checks at maximum intervals of 24 hrs, they did not standardize beyond that. Further, trap check intervals are never mentioned as a key element of BMPs (White *et al.* 2021, pg. 51). Standardization is particularly important when numerous different field locations, a substantial number of trappers, trap types, and preparation influence response variables. Standardization is imperative to a scientific comparison of trap devices. Without standardization, reproducibility and validity of the study is limited (Pawlina and Proulx1999). Concern over such limitations is ostensibly why the ISO guidelines are careful to specify that trap type evaluation should 1) be included within a trapping system, which includes standardization of methods are used, as there are infinite inputs that might trap site variation, and 2) be compared against a control, defined as the trap type most commonly used to trap a target species (ISO 1999). White *et al.* (2021) fell short of meeting these basic study design standards because, while different trap devices were described on pages 12–13, the authors did not standardize how traps are to be set beyond a cursory explanation that each trap station would be made up of 2 traps. Moreover, despite the use of 2 traps, there is no mention in White *et al.* (2021) of whether 1 of these traps is a control trap, though it is unclear why the authors set traps in pairs if they were not attempting to follow the ISO recommendations to use control traps. Apparently, no control trap is included, given control groups are never mentioned anywhere in the monograph.

Unreliable definition of capture efficiency

Standard capture efficiency (like catch per unit effort in fisheries) should be counted as number of captures per trap-period, e.g., per 100 trap nights (Proulx 1999; Powell and Proulx 2003; Proulx *et al.* 2020). The ISO standards specify this need for a time variable in their definition of efficiency, and most trapping studies use this metric (Table 1). By contrast, White *et al.* (2021) define efficiency as the capture rate of target animals, i.e., "*capability of a trap, as part of a trapping system, to capture target animals …expressed as a percentage of the total number of potential captures of target animals.*" (ISO 1999, page 1). Therefore, the authors include no time variable or trapping effort in their evaluation of capture efficiency, and risk confusing readers by using a metric that ISO standards do not use for the evaluation of traps. ISO (1999, page. 1) stipulates that trap test reports should include the following information: *i*) the number of captured target animals; *ii*) the number of traps set; and *iii*) the capture efficiency, i.e., "*the capability of the trap, as part of a trapping system, to capture target animals within a specific time period*"

By using capture rate instead of a true capture efficiency, the authors systematically overstate the 'efficiency' of every trap. If applying the standard method to calculate capture efficiency, estimates of trap efficiency would differ significantly from results of White *et al.* (2021). To illustrate, we compare outcomes from White *et al.* (2021) of the estimates of "capture efficiency" for 1 trap type (no. 11) used to capture northern raccoons in 1 yr (1999) to estimates derived using the ISO definition of capture efficiency (Table 2). Our estimates assume that traps were checked and set once every 24 hrs, and therefore only 1 raccoon could be captured per day. We cannot be sure this assumption is true, however, because White *et al.* (2021) use vague and imprecise language such as: "*We required trappers to check each trap and remove any animals once each day before 1200 hours…*" (page 15). This statement is unclear because it does not specify if some animals were removed after shorter periods of time (e.g., 4, 8, or 12 hrs). Furthermore, information is not provided to discern when traps were first set and reset after capture. In Figure 4 on page 14, the authors show an example of trap stations, and state in the caption that "*Each trapline consisted of a series of stations*." Because this is the only information provided about the number of traps set, we establish examples of the necessary assumptions pertaining to the number of traps set, and the resultant estimated capture efficiency that would be calculated for 3 differing trapping scenarios.

We estimate the highest possible capture efficiency for the no. 11 trap type is 78% (Table 2), whereas White *et al.*'s (2021) metric of number of captures/number of potential captures estimated an efficiency at 85.9%. The outcome by White *et al.* (2021) implies that if 439 raccoons approached the no. 11 trapping device, 377 would be captured. Potential captures could be calculated using trail cameras around traps which could observe when animals approached but were not captured by a trap. However, in this study, trap stations had no trail cameras, so researcher-trapper teams collected data on signs around the traps. From the information provided, we can only infer that someone estimated when and how much sign was left after the trap was assumed to have triggered but it is unclear how teams confirmed this sequence of events. On page 16, White *et al.* (2021) described a 'potential capture' in 3 scenarios when a trap device was activated by the focal species where 1) the individual "*was never restrained*" – the authors do not explain how a species

Table 2. Three possible trapping scenarios to illustrate how trapping effort impacts calculations of capture efficiency by 12 trapper teams trapping for northern raccoon (*Procyon lotor*) using trap type nos. 11 in 1999. Scenario 1 assumes that each trapper team set 4 traps for 10 d each. Scenario 2 assumes that each trapper team only set 2 traps, which is the minimum possible based on (White *et al.* 2021)'s methodology on page 14. This scenario is impossible given that there were more raccoons captured than the number of traps set. Scenario 3 illustrates an equally implausible scenario in which each trapper team trapped every day of 1999, each setting only 1 trap.

	No. Trapper Teams*	**No. of Raccoons Captured***	**No. Traps/trapper team**	**No. days of trapping/trapper team**	**Trap nights**	**Estimated Capture Efficiency**
Scenario 1	12	377	4	10	480	377/480= 78%
Scenario 2	12	377	2	10	240	377/240= 150%
Scenario 3	12	377	1	365	4,380	377/4,380= 8.6%

*Reported by White *et al.* (2021)

was identified in such a case; 2) the individual was "*captured but not restrained until trap inspection*" − again, this statement is not explained; and 3) the individual was "*captured and restrained until the trap was inspected*". Although the authors state that field researchers were trained by the authors, there is no explanation of how they were trained. The published study contains no analysis of field identification accuracy or inter-observer reliability. It is common in many studies to train community participants, but the best science validates the success of systematic and well documented training, which is included in the study design (Poisson *et al.* 2019; Brown and Williams 2018; Weidenhoeft *et al.* 2003).

Even if such estimates of potential captures could be made reliably, one would expect it to vary by site, habitat, year, or trapper set, not only by device. White *et al.*'s (2021) method defies fundamental principles of good wildlife science, which is that the actual number of raccoons (or any other wildlife species) visiting sampling sites is predicted by habitat quality, life history, threats, and demographics, among other factors, not by the effort and method of capture. Effort and method of capture produce estimates of detection probability or encounter rate, not the total number present. We conclude the methods used by White *et al.* (2021) are inadequate to properly assess the efficiency of any trap type because capture rate is not a substitute for measuring trap efficiency; the authors did not measure capture effort, i.e., number of traps and amount of time traps were open; and the authors' protocols for determining 'potential captures' are unclear and non-reproducible.

Missing parameters in animal welfare assessment

Each restraining trap studied was given an animal welfare score based on animal injury levels rated with a 0–100 trauma criterion (White *et al.* 2021, Table 2, page 16). Animals were scored during necropsies with a minimum sample size per species-trap device combination of *n*=20 (a sample size specified only in AIHTS; ECGCGRF 1997). Mortality, i.e., death caused directly by the trap, received a trauma score of 100, whereas a 0 resulted from no injury. We have several concerns about how animal welfare was calculated for each species-trap combination.

First, White *et al.* (2021) state "*We required a minimum sample size of 20 individuals of a given furbearing species per trap device...*" (page 15). However, it is unclear whether the minimum sample size of 20 animals necropsied had to be the first 20 of that species, or whether a trapper-researcher team could have discarded a member of the species and then included the 21st member trapped, for example. The unclear sampling scheme could introduce selection bias into the study and allows researcher bias to infiltrate. The risk of intentional or unintentional bias is concerning as the study occurred over a 20-yr period and the researchers did not explain how 20 carcasses were chosen for necropsy. For example, 76 northern river otters (*Lontra canadensis*) were captured in 3 trap types, but only 70 were necropsied, with no explanation as to why the other remaining 6 otters were not included in the evaluation (White *et al.* 2021, page 27).

Second, we question 3 decisions White *et al.* (2021) made regarding what to include in their animal welfare scoring. The authors appear to have only used *"…injury as the primary criterion to evaluate animal welfare.*." (page 16) in their necropsy evaluations, but omitted other potential metrics of welfare such as "*…criteria related to behavior, physiology (stress), immunology, and molecular biology*" (page 16) because they state "*the ISO process concluded there was insufficient knowledge or technology to incorporate those potential metrics*" (ISO 1999b: Annex A, Scope 1, paragraph 1.2)" (page 16). If our interpretation is correct, this suggests an incomplete necropsy procedure as exertion can result in internal bleeding, emphysema, or dislocation of proximal joints other than limbs (Proulx *et al.* 2012). Furthermore, the authors appear to omit some relevant conclusions regarding trapping impacts on animal welfare from the ISO guidelines. AIHTS and the Agreed Minute recognized the need for using other techniques than only necropsies, and the ISO standards indicated that physiology and behaviour assessments were in their infancy. Infancy does not mean absence; knowledge should be incorporated when it exists (Oreskes 2019). Furthermore, studies on raccoons (Proulx *et al.* 1993), red foxes (Kreeger *et al.* 1990; White *et al.* 1991), and other species (Cross *et al.* 1988; Chapple *et al.* 1991; Press *et al.* 1993; Groenink *et al.* 1994;) from the 1980s and 1990s have all shown that behavioural and physiological evaluations of trapped animals are possible. In fact, in Section 2.2 of AIHTS, under PARAMETERS, it is indicated: "*The parameters must include indicators of behaviour and injury listed in paragraphs 2.3.1 and 2.3.2*". White *et al.* (2021) could at least have used those methods on the well-understood species and analogized those findings to other species as a precaution. In the past 20 yrs, many more studies have been conducted on the physiology of captured animals. White *et al.* (2021) could have adopted such protocols at least at some point during their 20-yr study.

Third, the authors decided not to include self-inflicted wounds in their calculations of injuries, even though these are explicitly referenced as needing to be evaluated in AIHTS. "*Although not assigned injury points in and of itself, we also noted presence or absence of any self-directed biting on all animals during post-mortem examinations.*" (White *et al.* 2021, page 15). Not including self-inflicted injuries in injury scoring could bias the results to over-estimate humaneness, particularly for certain species such as raccoons, which are known to self-mutilate in leghold traps (Proulx *et al.* 1993; Hubert *et al.*, 1996). Self-mutilation is included in the AIHTS guidelines as an indicator of poor animal welfare caused by a trapping device (Proulx *et al.*, 1993; Talling and Inglis 2009). In the case of raccoons, encapsulated traps were developed by veterinarians and biologists to resolve the problem. In fact, no matter the proximate cause of an injury, it would not have occurred if the animal were not in a trap, therefore all injuries must be included to avoid under reporting of negative impacts of traps on animal welfare (Dellinger *et al.* 2023).

Finally, White *et al.* (2021) state "*Because our restraining-trap research was focused on injuries (including death) associated with the trap itself, we excluded from analysis animals that were already dead (or injured) upon trap inspection as a result of uncontrolled external variables (e.g., shot by another person, attacked by other animals, hypothermia, accidental drowning)*" (page15). With the exception of animals shot by another person, we do not know how the field teams discerned injuries or deaths as a result of external causes, or the frequency of such cases. The ISO (1999) specifies that all animals must be necropsied for trap device evaluation and does not state that researchers can disregard individual animals based on assumptions or subjective criteria, such as an assumption of external cause of death as suggested by White *et al.* (2021). AIHTS also lists "death" as an indicator of poor welfare in trapped wild animals. So, White *et al.*'s (2021) decision to remove death shows that the researchers did not follow established standards for assessing injuries or deaths contributed from restraining an animal in a trap that were not directly related to the trap. Again, the animal would presumably be alive were it not for the trapping event. Though not related necessarily to one trap device or another, the mortality does relate to the totality of circumstances that were determined by the trapper or the research protocol, i.e., the trapping system.

The physical restraint of a wild animal in restraining traps is analogous to temporary captivity, which is a well-studied animal welfare challenge. For animals in captivity, any harm that occurs is investigated and documented (Mason 2010). Here White *et al.* (2021) admit that the act of being restrained can lead to drowning and hypothermia because the animals are being held in a position that puts them at risk of these outcomes. Furthermore, we have observed some trappers employ methods of trap setting that ensure such outcomes to maximize their number of captures and ensure animals die more quickly. We argue that if hypothermia and drowning are a risk based on the location of trap devices, that all trap devices are inhumane in such sets. Furthermore, immobilization impedes trapped animals from fleeing or defending themselves from conspecifics and humans, increasing the possibility that an animal will be injured or die from these external inputs. According to the authors, they had a "*…goal of improving animal welfare in trapping*." (White *et al.* 2021, page 11). The authors' decision to omit such instances from necropsy or from analysis produce only bias in the direction that trappers and the trapping industry would favour, i.e., not a conservative assumption. Therefore, animal welfare scores should diminish each time an animal was injured or died as a result of being restrained.

Our last major concern with the animal welfare metric is the way the authors calculated cumulative injury scores of each individual animal-trap combination based upon mean injury scores (out of a sample size of 20). The use of an average is not comparable to a standard based on a minimum performance level because mean cumulative injury scores are affected by extremes. For example, in a sample of 20 animals, 16 out of 20 animals may have scores below 15, and 4 could have scores nearing 100 (Proulx *et al.* 2022a). In such a case the trap welfare score would be acceptable according to White *et al.* (2021) because the mean score is <55 points. This trap would also be approved under the AIHTS guidelines because 16/20 or 80% of animals have an injury score <50 points. However, with a result of 16/20 acceptable captures, the ability of the trap to capture animals with little or no injury would actually be 62% using a one-tailed binomial test (see Proulx *et al.* 2020), or in other words, 38% of all trapped animals could likely suffer unacceptable pain and distress when captured in such restraining traps. This more appropriate statistical assessment indicates that White *et al.*'s (2021) 'ISO/AIHTS mixed standards' and AIHTS can mislead and over-estimate humaneness. We therefore conclude that the animal welfare scoring employed by White *et al.* (2021) likely over-estimated the humaneness of any trap type because sample sizes of necropsies were small and samples may have been biased, the authors did not count self-inflicted wounds nor mortalities not directly caused by traps, and the calculation of injury scores were determined using means instead of a minimum performance level.

The confusion of selectivity and bycatch

"*We calculated trap-specific furbearer selectivity by dividing the total number of captures of furbearers that were legal to harvest by the total number of captures of all species…*" (White *et al.* 2021, page17). The authors justify the decision not to make the selectivity metric species specific by asserting that most trappers trap for >1 species at any given time. However, the literature is clear that selectivity should be species specific because traps that are non-discriminant could have devastating impacts to non-target species (Proulx 2022), particularly for species at risk (Proulx 2024). Furthermore, traps tested for 1 species may not be tested, or may have been determined inappropriate, for another species (Serfass 2022). Virgós *et al.* (2016) and Proulx (2022) argued that the definition of selectivity in ISO (1999) is inherently flawed because it does not account for the "*relative abundance of target and non-target species and represents only a simple rate or capture proportion…*" (Virgós *et al.* 2016, page 1411). White *et al.* (2021) repeat the error in their definition of selectivity by assuming all targeted species were as abundant as non-target species, a false assumption given the potential for capturing imperiled species (e.g., swift fox, *Vulpes velox*).

According to Virgos *et al.* (2016), a more accurate selectivity index would be Savage's W (see Manly *et al.* 2002), which could be written as: capture proportion of target species/population proportion of target species. The capture proportion is the current definition of selectivity used by ISO (1999), divided by a known proportion of target species. Savage's W is derived from ecological literature on resource selection and is therefore better justified than the methods used by White *et al.* (2021). White *et al.*'s (2021) methods do not clearly indicate that they estimated abundance of any animals in the populations subjected to trapping, therefore their metric of selectivity is only target animals divided by total animals. That metric accepts the idea of bycatch, on which there is literature from fisheries highlighting the problems with under-reporting illegal bycatch (Lescrauwaet *et al.* 2013; Basran and Mar Sigurosson 2021; Forget *et al.* 2021). The problem of under-reporting should be acknowledged when discussing capture selectivity.

Concerns about competing interests

Science is trusted or distrusted by the sovereign publics of many nations based in part on the appearance or existence of competing interests, whether financial or non-financial, or the appearance of scientific inquiry with preconceived notions or outcomes (Oreskes 2019). The pharmaceutical, biomedical, petroleum, and tobacco industries, and others have demonstrated their motivations to manipulate science for self-interest (Oreskes and Conway 2010). Therefore, the scientific fields studying these industries have had to embrace thoroughgoing transparency and disclosures. We do not observe similar disclosures in this instance. The text of the manuscript itself uses brand names from the industry as if these were neutral labels, which is not the case. The conclusions of such research that favour one or another brand of trap does represent an implicit endorsement of that manufacturer regardless of the disclaimer at the end of the acknowledgements. The authors could have used neutral identifiers indexed in supplementary material to link results to particular brands of traps rather than the constant citation to manufacturers.

We have concerns with White *et al.*'s authors' affiliations and incomplete disclosures. U.S. state wildlife agencies (most co-authors in White *et al.* 2021) generate revenues from trapping permits. The Association of Fish & Wildlife Agencies (AFWA, lead author) has a stated interest in promoting trapping, which is demonstrated through marketing materials contained on AFWA web page on trapping. US States receive federal funds from the Pittman-Robertson Act among other sources. Also, some federal agencies, such as USDA-APHIS-Wildlife Services (1 co-author at least), develop cooperative contracts with municipalities, counties, states, tribes, etc., in which they are paid to live- and kill-trapping wildlife. While the monetary amount of these contracts may vary, their existence creates a direct financial competing interest with impartial treatment of research; the undue political and financial influence of wildlife-killing individuals and organizations have been meticulously documented (Clark and Milloy 2014). Also, professional societies that advocate for trapping, such as AFWA (lead author), The Wildlife Institute (another co-author), and The Wildlife Society (publisher of the journal hosting White *et al.* 2021) are not value-neutral organizations (as explained in the introduction, "TWS Position Statement: Trapping Furbearers" July 7, 2020). Therefore, various competing interests (career advancement, direct financial interests, and various individual motivations) may impact White *et al.* 's (2021) monograph and they need to disclose them. We urge journals publishing potentially controversial information on consumptive use of wildlife to impose greater transparency in cases akin to White *et al.* (2021) where one or more authors' affiliated agencies appear to have a competing interest to minimize the negative perceptions of trapping.

Conclusion

Trapping technology has been highly controversial in the last 40 yrs (Proulx and Barrett 1989; Proulx 2022), and trade-oriented standards such as ISO and AIHTS have been highly criticized in the past (Iossa *et al.* 2007; Proulx *et al.* 2020).

In Summary:

Did White *et al.*'s (2021) study properly implement ISO or AIHTS standards? **NO**

Did White et al. (2021) implement a scientifically sound and replicable research protocol? **NO**

White *et al.*'s (2021) research protocol inadequacies	**Characteristics of a scientifically sound and replicable trap evaluation protocol**
• Assessment of individual traps only.	• Assessment of trapping systems.
• No use of control trapping systems.	• Use of control trapping systems to better assess humaneness, capture efficiency and selectivity.
• Determination of capture rate.	• Determination of capture efficiency.
• Times of trap setting and checking unknown.	• Times of trap setting and checking known.
• Duration of captivity for each animal unknown.	• Duration of captivity known.
• Selectivity of the traps not determined.	• Selectivity of trapping systems is determined.
• Small (*n*=20) sample size with unknown selection criteria	• Minimum sample size required to analyze and predict the performance of trapping systems. All captured animals are being included.
• Humaneness of traps based on injuries only.	• Humaneness of traps based on total body necropsies, and other criteria such as behavioural and physiological changes.
• Assessments did not include self-inflicted injuries and deaths in traps.	• All injuries and deaths are included in the assessments.
• Acceptation of traps based on mean injury scores affected by extreme values.	• Acceptation based on a minimum percentage of animals with minor or no injuries, e.g., ≥80% of animals.
• Minimum acceptation level of 62% of animals.	• Minimum acceptation level of ≥80% of animals.

Future directions:

During the last 40 yrs, injury scores, and behavioural and physiological changes, have been used to assess trap humaneness, and capture efficiency and selectivity. Minimum trap performance levels have also been significantly increased. Enhanced trap assessment protocols and performance levels could have been used in White *et al.*'s (2021) study, and should be used in future trap research and development programs through the implementation of state-of-the-art scientific protocols (Proulx *et al.* 2022a,b,c).

Trap research and evaluation must be representative of emerging knowledge in trapping and scientific method, and we believe that White *et al.*'s (2021) study failed in both cases. Science-based resource management depends on validated measures that are accurate (do not systematically under- or over-estimate the parameter in question), precise (narrow margins of uncertainty around measures), and sensitive to changing conditions (reliable and generalizable to new areas and other periods) (Creel 2021; Treves 2022). We found few of these hallmarks of rigorous science in the methods presented by White *et al.* (2021) because they did not test trap systems, compare to control traps, nor standardize trap setting and trap check frequencies. Further White *et al.* (2021) incorrectly defined capture efficiency, chose not to include certain deaths and injuries in welfare scoring, and did not measure species-specific selectivity. Any BMPs developed for furbearer trapping must carefully examine each trap type using the strongest scientific methods and reducing biases to the greatest degree possible in order to ensure humaneness of trapping practices.

We realize the challenges inherent in long-term studies such as that described by White *et al.* (2021), given our experience in fur-trapping and long-term studies (see Proulx 1999; Niemeyer and Evans 2012; Naughton-Treves *et al.* 2017; Serfass 2022). However, long-term does not inherently equate to high quality. The standards used by White *et al.* (2021) do not correspond to either ISO or AIHTS standards. White *et al.*'s (2021) study employed a mixture of criteria and parameters from one but not both standards, and in some cases, apparently elaborated by the authors themselves. The analysis methods used by White *et al.* (2021) are flawed, not transparent, and irreproducible. Therefore, we question the outcomes of the study as representing best management practices for capturing furbearing animals in restraining traps.

We conclude that White *et al.* (2021)'s study should be redone with a comprehensive, standardized approach and new parameters.

Acknowledgements

We would like to thank B. Galdenzi for raising questions about the original research. We thank the Editorial Office of Canadian Wildlife Biology & Management who assured us that our paper would be reviewed by professionals specialized in wildlife biology and research, animal health, and wildlife management issues. We are grateful for the comments made by Dr. Ciska de Ruyer and 4 anonymous referees who all accepted our manuscript with minor revision.

Declarations of competing interests

Authors declare no competing interests but disclose the following for readers to judge for themselves. AT funding history http://faculty.nelson.wisc.edu/treves/archive_BAS/funding.pdf and complete CV at http://faculty.nelson.wisc.edu/treves/archive_BAS/Treves_vita_latest.pdf, accessed March 2024. The points set forward in this publication were based on previous, extensive research on humane trapping and trap assessments conducted over several decades by GP (see pertinent publications at https://www.researchgate.net/profile/Gilbert-Proulx/research) and TS (see pertinent publications at https://www.researchgate.net/profile/Thomas-Serfass/research). The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be perceived as a potential conflict of interest.

Literature cited

Agreed Minute. 1998. International agreement in the form of an agreed minute between the European Community and the United States of America on humane trapping standards. Official Journal of European Communities, L219, 26–37.

Association of Fish and Wildlife Agencies (AFWA). Undated. Conservation brief: regulated trapping and the North American Model of Wildlife Conservation. https://www.fishwildlife.org/application/files/1416/4133/5436/Final_NAModel_Conservation-Brief. pdf. Accessed November 2023.

Basran, C. J., and G. M. Sigurosson. 2021. Using case studies to investigate cetacean bycatch/interaction under-reporting in countries with reporting legislation. Frontiers in Marine Science 8: 779066.

Batcheller, G. R., T. A. Decker, D A. Hamilton, and J. F. Organ. 2000. A vision for the future of furbearer management in the United States. Wildlife Society Bulletin 28: 833–840.

Boggess, E. K., G. R. Batcheller, R. G. Linscombe, J. W. Greer, M. Novak, S. B. Linhart, D. W. Erickson, A. W. Todd, D. C. Juve, and D. A. Wade. 1990. Traps, trapping, and furbearer management: a review. Technical Review90-1. The Wildlife Society, Bethesda, Maryland, USA.

Brown, E. D., and B. K. Williams. 2018. The potential for citizen science to produce reliable and useful information in ecology. Conservation Biology 33: 561–569

Caravaggi, A., T. F. Amado, R. K. Brook, S. Ciuti, C. T. Darimont, M. Drouilly, H. M. English, K. A. Fild, G. Iossa, J. E. Martin, A. G. McElligott, A. Mohammadi, D. Nayeri, H. M. K. O'Neill, P. C. Paquet, S. Périquet, G. Proulx, D. Rabaiotti, M. R. Recio, C. D. Soulsbury, T. Tadich, and R. Wynn-Grant. 2021. On the need for rigorous welfare and methodological reporting for the live capture of large carnivores: a response to de Araujo *et al.* (2021). Methods in Ecology and Evolution 12: 1793–1799.

Chapple, R., A. English, R. Mulley, and E. Lepherd. 1991. Haematology and serum biochemistry of captive unsedated chital deer (*Axis axis*) in Australia. Journal of Wildlife Diseases 27: 396–406.

Clark, S. G., and C. Milloy. 2014. The North American Model of Wildlife Conservation: an analysis of challenges and adaptive options. Pages 339–390 *in* S. G. Clark, and M. B. Rutherford, editors. Large carnivore conservation: integrating science and policy in the North American West. University of Chicago Press, Chicago, Illinois, USA.

Conejero, C., Lopez-Olvera, J. R., Gonzalez-Crespo, C., Raez-Brazo, A., Castillo-Contreras, R., Tampach, S., Velarde, and R. Mentaberre, G. 2022. Assessing mammal trapping standards in wild boar drop-net capture. Scientific Reports 12: 15090.

Creel, S. 2021. Methods to estimate population sizes of wolves in Idaho and Montana (Federal Register 86: 51857). Available at: https://westernwatersheds.org/wp-content/uploads/2024/02/Creel-Wolf-Report_FINAL.pdf . Accessed March 2024.

Cross, J., C. Mackintosh, and J. Griffin. 1988. Effect of physical restraint and xylazine sedation on haematological values in red deer (*Cervus elaphus*). Research in Veterinary Science 45: 281–286.

Dellinger, J. A., A. F.Basto, , T. W. Vickers, , C. C. Wilmers, , J. A. Sikich, , S. P. D. Riley, , D. Gammons, , Q. E. Martins, , H. U. Wittmers, , D. K. Garcelon, , M. L. Allen, , B. Cristescu, , and D. L. Clifford. 2023. Evaluation of the effects of multiple capture methods and immobilization drugs on mountain lion welfare. Wildlife Society Bulletin 47(4): e1494

De Ruyver, C., K. Baert, E. Cartuyvels, L. A. L. Beernaert, F. A. M. Tuyttens, H. Leirs, and C. P. H. Moons. 2023. Assessing animal welfare impact of fourteen control and dispatch methods for house mouse (*Mus musculus*), Norway rat, (*Rattus norvegicus*) and black rat (*Rattus rattus*). Animal Welfare 32 (e2): 1–10.

ECGCGRF (European Community, Government of Canada, and Government of the Russian Federation). 1997. Agreement on international humane trapping standards. Official Journal European Communities 42: 43–57.

Feldstein, P., and G. Proulx. 2022. Inadequate implementation of AIHTS mammal trapping standards in Canada. Pages 129–140 *in* G. Proulx, editor. Mammal trapping – Wildlife management, animal welfare & international standards. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Forget, F., J. Muir, M. Hutchinson, D. Itano, I. Sancristobal, , B. Leroy, , J. Filmalter, , U. Marinez, K. Holland, V. Restrepo, and L. Dagorn. 2021. Quantifying the accuracy of shark bycatch estimations in tuna purse seine fisheries. Ocean & Coastal Management 210: 105637.

Groenink, L., J.Van Der Gugten, , T. Zethof, , J. Van Der Heyden, and B. Olivie. 1994. Stress-induced hyperthermia in mice: hormonal correlates. Physiology & Behavior 56: 747–749.

Hubert Jr, G. F., L. L. Hungerford, G. Proulx, R. D. Bluett, and L. Bowman. 1996. Evaluation of two restraining traps to capture raccoons. Wildlife Society Bulletin 24: 699–708.

Internation Organization for Standardization (ISO). 1999. Animal (mammal) traps- Part 5: methods for testing restraining traps. (10990-5).

Iossa, G, C. D. Soulsbury, and S. Harris. 2007. Mammal trapping: a review of animal welfare standards of killing and restraining traps. Animal Welfare 16: 335–352.

Kreeger, T., P. White, U. Seal, and J. Tester. 1990. Pathological responses of red foxes to foothold traps. Journal of Wildlife Management 54: 147–160.

Lescrauwaet, A., E. Torreele, , M. Vincx, H. Polet, and J. Mees. 2013. Invisible catch: a century of bycatch and unreported removals in sea fisheries, Belgian 1929–2010. Fisheries Research 147: 161–174.

Manly, B. F. J., L. L. McDonald, D. L.Thomas, T. L. McDonald, and W. P. Erickson. 2002. Resource selection by animals. Kluwer Academic Publishers, Dordecht, Netherlands.

Mason, G. J. 2010. Species differences in responses to captivity: stress, welfare and the comparative method. Trends in Ecology & Evolution 25: 713–721.

Michaud, P. V. 1997. Caught in a trap: the European Union leghold trap debate. Minnesota Journal of International Law 138: 355–379.

Naughton-Treves, L., J. L'Roe, A. L'Roe, and A. Treves. 2017. A long-term comparison of local perceptions of crop loss to wildlife at Kibale National Park, Uganda: exploring consistency across individuals and sites. Pages 127–147 *in* C. M, Hill, A. D. Webber, and N. E. C Priston, editors. Understanding conflicts about wildlife: a biosocial approach. Berghahn Books, New York, New York, USA.

Niemeyer, C., and N. Evans. 2012. Wolfer: a memoir. BottleFly Press, USA.

Oreskes, N. 2019. Why trust science? Princeton University Press, Princeton, New Jersey, USA.

Oreskes, N., and E. M. Conway. 2010. Merchants of doubt: how a handful of scientists obscured the truth on issues from tobacco smoke to global warming. Bloomsbury Press, London, UK.

Organ, J.F., T. Decker, S. Langlois, and P. G. Mirick. 2015. Trapping and furbearer management in North

American wildlife conservation. Available at: https://www.dec.ny.gov/docs/wildlife_pdf/trapfurmgmt.pdf. Accessed April 2024.

Pawlina, I., and G. Proulx. 1999. Factors affecting trap efficiency: a review. Pages 95–115 *in* G. Proulx, editor. Mammal trapping, Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Poisson, A. C., I. M. McCullough, K. S. Cheruvelil, , K. C. Elliott, J. Latimore, and P. A. Soranno. 2019. Quantifying the contribution of citizen science to broad-scale ecological databases. Frontiers in Ecology and the Environment 18: 19–26.

Powell, R. A., and G. Proulx. 2003. Trapping and marking terrestrial mammals for research: integrating ethics, performance criteria, techniques, and common sense. ILAR Journal 44: 259–276.

Press, F., F. Manson, O. Ruyle, , O. Hasson, , R. Rice, and N. Weis. 1993. Haematology of Spanish ibex (*Capra pyrenaica hispanica*) restrained by physical or chemical means. The Veterinary Record 132: 580–583.

Proulx, G. Editor. 1999. Mammal trapping. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Proulx, G. 2022. The five Ws of mammal trapping. Pages 1−21 *in* G. Proulx, editor. Mammal trapping − Wildlife management, animal welfare & international standards. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Proulx, G. 2024. How does non-selective trapping affect species at risk in Canada? Pages 133–158 *in* G. Proulx, editor. Wildlife conservation & management in the 21st century – Issues, solutions and new concepts. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Proulx, G, B. L. Allen, M. Cattet, P. Feldstein, G. Iossa, P. D. Meek, T. L. Serfass, and C. D. Soulsbury. 2022a. International mammal trapping standards − Part I: Prerequisites. Pages 259− 271 *in* G. Proulx, editor. Mammal trapping − Wildlife management, animal welfare & international standards. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Proulx, G, B. L. Allen, M. Cattet, P. Feldstein, G. Iossa, P. D. Meek, T. L. Serfass, and C. D. Soulsbury. 2022b. International mammal trapping standards−Part II: Killing trap systems. international Pages 233 −258 *in* G. Proulx, editor. Mammal trapping − Wildlife management, animal welfare & international standards. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Proulx, G, B. L. Allen, M. Cattet, P. Feldstein, G. Iossa, P. D. Meek, T. L. Serfass, and C. D. Soulsbury. 2022c. International mammal trapping standards − Part III: Restraining trap systems. Pages 273−285 *in* G. Proulx, editor. Mammal trapping − Wildlife management, animal welfare & standards. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Proulx, G. and M. W. Barrett. 1989. Animal welfare concerns and wildlife trapping: ethics, standards and commitments. Transactions of the Western Section of the Wildlife Society 25: 1–6.

Proulx, G., M. Cattet, T. L. Serfass, and S. E. Baker. 2020. Updating the AIHTS trapping standards to improve animal welfare and capture efficiency and selectivity. Animals 10, 1262; doi:10.3390/ANI10081262.

Proulx, G., M. R. L. Cattet, and R. A. Powell. 2012. Humane and efficient capture and handling methods for carnivores. Pages 70–129 *in* L. Boitani and R. A. Powell, editors. Carnivore ecology and conservation: a handbook of techniques. Oxford University Press, London, UK.

Proulx, G., D. K. Onderka, A. J. Kolenosky, P. J. Cole, R. K. Drescher, and M. J. Badry. 1993. Injuries and behavior of raccoons (*Procyon lotor*) captured in the Soft Catch™ and the EGG™ traps in simulated natural environments. Journal of Wildlife Diseases 29: 447–452.

Proulx, G., D. Rodtka, M. W. Barrett, M. Cattet, D. Dekker, E. Moffatt, and R. A. Powell. 2015. Humaneness and selectivity of killing neck snares used to capture canids in Canada: a review. Canadian Wildlife Biology & Management 4: 55–65.

Responsive Management. 2015. Trap use, furbearers trapped, and trapper characteristics in the United States in 2015 [Report for Association of Fish and Wildlife Agencies]. Responsive Management, Harrisburg, USA.

Serfass, T. L. 2022. Animal welfare issues pertaining to the trapping of northern river otters: a review. Pages 23–48 *in* G. Proulx, editor. Mammal Trapping − Wildlife Management, Animal Welfare & International Standards. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Serfass, T. L., and G. Proulx. 2024. Trapping and the North American Model of Wildlife Conservation: incongruities demonstrated through the northern river otter. Pages 119–132 *in* G. Proulx, editor. Wildlife conservation & management in the 21st century – Issues, solutions and new concepts. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.

Talling, J. C., and I. R Inglis. 2009. Improvements to trapping standards. DG ENV.. Available at: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=44cc432b6a1c30c94d61ff8acebe5232e8e59509. Accessed April 2024

The Wildlife Society (TWS). 2020. TWS position statement: trapping furbearers. TWS. Available at: https://wildlife.org/tws-standing-position-traps-trapping-and-furbearer-management/#:~:text=Recognize%20that%

20furbearer%20trapping%2C%20when,managing%20and%20studying%20wildlife%20populations. Accessed June 2024.

Treves, A. 2022. '"Best available science" and the reproducibility crisis. Frontiers in Ecology and the Environment 20: 495–495.

Virgós E., J. Lozano, S. Cabezas-Díaz, D. W. Macdonald, A. Zalewski, J. C. Atienza, G. Proulx, W. J. Ripple, L. M. Rosalino, M. Santos-Reis, P. J. Johnson, A. F. Malo, and S. E. Baker. 2016. A poor international standard for trap selectivity threatens global carnivore and biodiversity conservation. Biodiversity and Conservation: doi 10.1007/s10531-016-1117-7.

Wiedenhoeft, J. E., S. R. Boles, and A. P. Wydeven, Editors. 2003. A volunteer carnivore tracking program and its potential use in monitoring the timber wolf (*Canis lupus*) population in northern and central Wisconsin. World Wolf Congress 2003: bridging science and community, Banff, Alberta, Canada.

White, B. H. T. Decker, M. J. O'Brien, J. F. Organ, and N. M. Roberts. 2015. Trapping and furbearer management in North American wildlife conservation. International Journal of Environmental Studies 72: 756–769.

White, H. B., G. R. Batcheller, E. K. Boggess, C. L. Brown. W. Butfiloski, J. T. A. Decker, J. D. Erb, M. W. Fall, D. A. Hamilton, and T. L. Hiller. 2021. Best Management Pactices for trapping furbearers in the United States. Wildlife Monographs 207: 3–59.

White, P., T. Kreeger, U. Seal, and J. Tester. 1991. Pathological responses of red foxes to capture in box traps. Journal of Wildlife Management 55: 75–80.

ABOUT THE AUTHORS

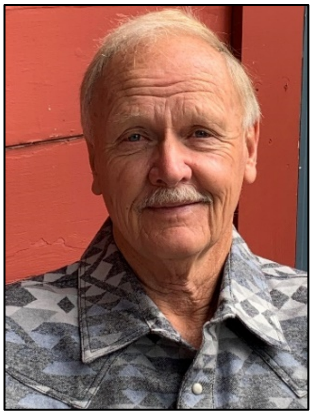
Naomi X. Louchouarn earned her PhD and currently works part-time as a research scientist at the Nelson Institute at the University of Wisconsin-Madison, USA, and full-time as a river restoration project manager for the Grand Traverse Band of Ottawa and Chippewa Indians. She received her Bachelor's of Science from McGill University with dual minors in wildlife biology and applied ecology. She then received a Master's of Environmental Science and Management at UC-Santa Barbara's Bren School where she focused on conservation planning. Her PhD research has focused on examining the effectiveness of tools and policies to mitigate human-carnivore conflict in North America. She has also explored and published peer-reviewed papers about what makes high-quality carnivore science.

Gilbert Proulx is a wildlife biologist with nearly 50 yrs of field experience. He is Director of Science at Alpha Wildlife Research & Management, and Editor of the scientific journal Canadian Wildlife Biology & Management. Gilbert obtained a BS in Biology from the Université de Montréal, an MS in Biology from the Université du Québec à Montréal, and a PhD in Zoology from the University of Guelph. He has published 184 refereed papers in scientific journals and books, and 18 peer-reviewed textbooks and field guides. His main research interests focus on mammals, particularly in forest and agriculture ecosystems, and on technology development, mainly mammal trapping and detection methods. Although Gilbert was not involved in the development of ISO and AIHTS mammal trap standards, he developed the protocols for the assessment of the humaneness of mammal traps, which were partially adopted by ISO and AIHTS. Gilbert supervised the development of several trapping systems which outperformed current mammal trapping standards. He recently led an international scientific team in the development of standards that effectively addressed the welfare of animals captured in trapping systems, and trap selectivity and efficiency.

Tom Serfass is a professor of Wildlife Ecology in the Department of Biology and Natural Resources at Frostburg State University. He has worked on northern river otter (*Lontra canadensis*) conservation for over 30 yrs, having conceived and supervised the Pennsylvania River Otter Reintroduction Project, coordinated research for the New York Otter Project, and served as a consultant for the reintroduction of river otters in New Mexico. Most recently, Tom has been conducting research with spotted-necked otters (*Hydrictis maculicollis*) at Rubondo Island National Park, Tanzania,

and river otters in Greater Yellowstone Ecosystem. Tom is the North American Coordinator for the IUCN Otter Specialist Group.

Carter C. Niemeyer has BS (1970) and MS (1973) degrees in wildlife biology from Iowa State University. He has been a state trapper for the Montana Department of Livestock, and



a district supervisor for USDA Wildlife Services in western Montana managing and controlling large predators. He was chosen as the wolf (*Canis lupus*) management specialist for USDA Wildlife Services covering the states of Idaho, Montana and Wyoming. In that position, he was responsible for livestock depredation investigation, as well as wolf capture and removal. Niemeyer was a member of the wolf capture team in Canada during reintroduction in the mid-1990s. In 2001 he was recruited by the U.S. Fish and Wildlife Service to run the agency's wolf recovery program in Idaho, and retired in 2006, coincidentally on the same day that wolf management was officially handed over to the state of Idaho. He also has worked on wolf issues in Washington, Oregon and California, as well as England, Scotland, France and Kyrgyzstan. He wrote his first memoir, Wolfer, in 2010. His second memoir, Wolf Land was published in 2016. Most recently he served as an advisor on the Technical Working Group (TWG) in Colorado to develop a plan to restore and manage gray wolves.

Adrian Treves focuses on ecology, scientific integrity, public trust principles, and agro-ecosystems where crops and

domestic animals overlap carnivore habitat. He and his lab have authored >160 scientific articles, best known for their gold-standard experiments on non-lethal prevention of predation on domestic animals, estimates of illegal wolf-killing and cryptic poaching, and work on risk maps to predict human-carnivore conflict sites. Founder and Director of the Carnivore Coexistence Lab, and Professor of Environmental Studies at the University of Wisconsin–Madison, Adrian earned his PhD at Harvard University in 1997.

Received 8 May 2024 – Accepted 26 June 2024