Chapter 1

The Five Ws of Mammal Trapping

Gilbert PROULX
Alpha Wildlife Research & Management Ltd., 229 Lilac Terrace, Sherwood Park, Alberta, T8H 1W3, Canada. Email: gproulx@alphawildlife.ca

Abstract − In this paper, I review questions about the 5 Ws − Who, What, When, Where, and Why − of mammal trapping that I judge significant to better understand the pros and cons of mammal trapping: who traps mammals and who objects to such activities; who is responsible for professional and ethical mammal trapping; what is mammal trapping, the performance thresholds of standards, capture efficiency, and selectivity; what alternatives can be used to mammal trapping; why mammal trapping is necessary; why mammal trapping is controversial; when mammal trapping should be allowed; when concerns about mammal trapping will stop; where trapping should occur; and where we should focus our attention in mammal trapping. This review points out that there is recurrent questioning about the necessity of mammal trapping and the welfare of trapped animals. On the basis of this review, I recommend the use of a decision process to justify mammal trapping in 5 categories: sustenance, research, human-wildlife conflict, fur trapping, and wildlife management. I suggest that the common denominator for all these mammal trapping categories is the necessity to use state-of-the-art trapping technology and species-selective trapping systems.

Introduction

More than 2,000 years ago, humans trapped mammals for food and clothing, and probably to protect their families from predators (Proulx 1999a). The early trapping devices were relatively crude, and consisted of snares, deadfalls and pitfalls that were not selective and likely did not kill animals quickly. In those days, the welfare of captured animals was not a concern − people trapped for their survival.

Today, many people still trap mammals as a way of life or a recreational activity, to control nuisance animals or predators, to sell furs, glands or skulls, to implement specific wildlife management programs, or to carry out research on populations and habitats. However, mammal trapping is a source of concern for the public and wildlife professionals. While current standards such as those of the International Organization for Standardization (ISO 1999a,b) and the Agreement on International Humane Trapping Standards (AIHTS; ECGCGRF 1997) do not reflect state-of-the-art trapping technology and poorly address animal welfare issues (Proulx *et al.* 2020), the public continues to wonder about mammal trapping, wildlife conservation, and the treatment of animals (Bekoff 2002; McLaren *et al.* 2007).

In order to understand the benefits as well as the drawbacks of mammal trapping, it is important to review mammal trapping in the context of its history and today's influences and events. Therefore, in this paper, I review questions about the 5 Ws − Who, What, When, Where, and Why − of mammal trapping. There is no limit to the number of questions that may be asked under these categories. I focused on those that I heard or discussed the most often in more than 45 yrs as a field wildlife biologist, trapper, researcher, and manager.

Who

Many people trap animals, and many others object to animal trapping. In wildlife conservation, it is essential to understand diverging views and biases vis-à-vis trapping, animal welfare, and trade in order to develop sound wildlife management programs.

Who traps mammals?

Indigenous peoples

The technology and use of restraining and killing traps (e.g., snares, deadfalls, slab-ice and stone traps) to capture mammals is well documented historically in Africa (Wadley 2010), Europe (Charles 2002), and North America (McGee 1987; Wright 1987; Shaffer *et al.* 1996). In Canada, subsistence harvesting regimes remain important to some Aboriginal peoples, particularly those living in the isolated regions of the north. These Aboriginal communities prefer these lifestyles (Standing Committee on Aboriginal Affairs and Northern Development [SCAAND] 1986) where the traditional bush lifestyle does not merely represent a symbolic heritage, but rather survives as lived experience (Nelson *et al.* 2005). However, wage employment, a wide range of consumer goods, and more and more Aboriginal people moving to cities are among the factors that caused a significant decrease in trapping among Indigenous peoples (Nelson *et al.* 2005). Stabler *et al.* (1990) and George *et al.* (1995) suggested that many northern Native communities in Canada were best characterised in terms of a mixed economy, one in which people 'going in between' reflects the complementarities of the wage-based economy and the hunter-gatherer economy. Greater participation in fur trapping is best explained by the lack of alternative employment opportunities (Stabler *et al.* 1990). Many Indigenous trappers may therefore be recorded as fur trappers (see below), but their participation in the fur industry may not be consistent from year to year. Subsistence trapping (snaring) is also an important activity carried out by villagers in some African countries (Ntiamoa-Baidu 1997; Noss 2008). Elsewhere, a few Aboriginal communities also adapted to new available resources such as the brushtail possum (*Trichosurus vulpecula*), a primarily herbivorous arboreal marsupial that was introduced into New Zealand from its Native Australia in 1858 to establish a fur trade and has since become widespread and abundant (Cowan 2005). The fur and skins of the possum now represent a valuable economic resource to small, predominantly rural Māori (Indigenous people of New Zealand) communities (Jones *et al.* 2012).

Fur trappers

In North America, the fur trade is more than 600 years old. It is considered an important industry by trapper organizations because it involves thousands of participants (Association of Fish and Wildlife Agencies 2015; Fur Institute of Canada 2019) and contributes to a country's Gross National Income. For example, in Canada, in 2009-2010, 730,915 pelts generated nearly $ 15 millions CAD (Statistics Canada 2010). However, the industry is down with large quantities of furs that are sold at low prices or simply unsold (CBC News 2020; Trapping Today 2020). As is the case with Indigenous peoples, a high portion of licensed trappers may not engage in trapping (Dorendorf *et al.* 2016), and fur harvest is largely influenced by economic factors, e.g., pelt price (Gregory *et al.* 2019). Some people consider that trappers are "weekend warriors", i.e., trapping is a hobby and they go out once a week to check traps and snares (Rocky Mountain Outpost 2016). Nevertheless, in North America, trapping remains a serious pursuit for a group of participants who trap primarily as a valued component of an outdoor lifestyle, maintaining tradition and a utilitarian outdoor activity (e.g., Todd and Boggess 1987; Zwick *et al.* 2002). However, relative to other forms of land use, the market value of fur is small, almost insignificant (Adamowicz and Condon 1987).

Trappers represent a socio-political force that may be used to protect wilderness areas from industrial development (Proulx and Barrett 1991). However, contrary to claims made by some people and organizations (e.g., Alberta Trappers' Association 2019; BC Trappers Association 2021; Molvar 2021), trappers are not wildlife managers. Fur harvesting is only one tool among others used by wildlife biologists to monitor and manage wild animal populations (see Wildlife Management below). Generally, trappers do not monitor the status of populations, natality and mortality rates, age and sex ratios, and home ranges (which may encompass many traplines) vs. habitat changes. Trappers do not address management

intricacies associated with species reintroduction programs, species at risk, and new taxonomic classifications. Monitoring changes in furbearer populations and harvest levels, as well as factors contributing to these changes, is necessary to make sound management decisions (Dorendorf *et al.* 2016). However, previous studies have repeatedly found that fur values play a key role in trapper participation (Siemer *et al.* 1994; Elsken-Lacy *et al.* 1999; Gehrt *et al.* 2002; Ahlers *et al.* 2016; Gregory *et al.* 2019). Effective wildlife management is not a part-time activity; it requires consistent, reliable, and factual information about populations and habitats. Wildlife population analyses and wildlife management programs should be re-assessed on a yearly basis, independently of fluctuations in pelt values or other economic factors associated with fur harvests. While wildlife managers take into consideration human activities, they must protect native biodiversity (individuals, species, populations, ecosystems) and the ecological functions and processes that maintain biodiversity (Paquet and Darimont 2010). These are hardly the activities of fur trappers.

Fur trappers are also active in Europe and some are well organized (Union Nationale des Associations de Piégeurs Agréés de France 2019; Hunters of Europe 2021). However, trapping statistics and research appear limited to occasional data on the efficiency of catching animals (e.g., Díaz-Ruiz *et al.* 2010; Short *et al.* 2012).

Pest and predator controllers

Trapping is used extensively in the removal of animals that impact on the wellbeing of human populations, their property, and their activities (Meyer 1991). In urban areas, farms and ranches, commensal species of rats and mice can reach high densities (Corrigan 2001; Witmer and Proulx 2010) that can result in increased cases of rodent-borne disease transmission to humans (e.g., Hjelle and Glass 2000). In agricultural regions, fossorial rodents such as northern pocket gophers (*Thomomys talpoides*) may seriously reduce the annual productivity of hay fields, and must be controlled through trapping (Proulx 1997).

Pest control is not limited to rodents, however, and can include carnivores, which may also be trapped and vaccinated against diseases such as rabies (Rosatte *et al.* 1990). In Australia, most trappers surveyed by Meek *et al.* (2018) categorised themselves as professional trappers, split more or less evenly between government employees and non-government contractors. Their main work is associated with the control of wild dogs (*Canis lupus familiaris*) and red foxes (*Vulpes vulpes*). In many regions of Australia, dingoes (variously referred to as *Canis dingo*, *C. familiaris*, and C. *lupus dingo*; van Eeden *et al.* 2019) and other wild dogs have been largely eradicated to accommodate sheep (*Ovis aries*) production (Fleming *et al.* 2001). Trapping is also used to remove stoats (*Mustela erminea*) and other predators of many forest birds in New Zealand (Dilks *et al.* 2003).

In some circumstances, predator control may be necessary to remove carnivores feeding on people or endangered species (Proulx 2018a). While some pest controllers may also be fur trappers, many of them belong to organizations such as the Canadian Pest Management Association and the National Pest Management Association.

Scientific Researchers

Mammal trapping is vital to scientific research and management as it allows wildlife biologists to collect information on population dynamics, health, and genetics. Mammal trapping may be used to assess the general distribution of a species and better understand habitat selection by animals (Proulx and Barrett 1991). Captured animals may be equipped with radio-transmitters (Fuller and Fuller 2012), behavioural, physiological, and environmental sensors (Whitford and Klimley 2019), and even cameras to better study their behaviours and environments (Watanabe *et al.* 2006; Patel *et al.* 2017).

Wildlife managers

The management of furbearers involves the manipulation of their populations and their habitats (Wolfe and Chapman 1987). It is carried out by wildlife biologists who develop programs to monitor the biological status of each species and maintain viable populations of each species. In jurisdictions where fur harvesting and animal control occur, programs may aim to optimize the harvest of the furbearer resource when furs

are in prime, and avoid overexploitation, minimize animal damage, and provide the public with recreational, economical and ecological benefits (Proulx and Barrett 1991).

People of all walks of life

Most urban and sub-urban dwellers use traps to remove commensal rodents that invade their property. Of course, most of them have no training in trapping, and they reluctantly capture mice and rats in snap-traps (many of them being disposable single-use traps) purchased at their local hardware store.

Who objects to mammal trapping?

Mammal trapping is a highly controversial invasive activity that often results in the death of captured animals. Also, it has been the subject of constant criticism since the 1900s by both the public and the scientific world.

Animal welfare and animal rights organizations

Organized campaigns against the use of leghold traps and opposition to trapping originated in the USA in the 1920s (Gerstell 1985) and in Canada in the 1940s (SCAAND 1986). Since the 1950s, hundreds of new animal welfare and animal rights organizations have developed and represent a major challenge to the wild fur industry (Barrett *et al.* 1988). Unfortunately, pro-trapping agencies fail to differentiate animal welfare groups from animal rights organizations (see White *et al.* 2020). While these organizations may express anti-trapping sentiments, there is a major difference in their agenda.

Animal welfare organizations are concerned with the welfare of animals. They object to trapping systems which cause undue pain and suffering to captured animals by causing serious injuries, or involving long periods of distress before death. The Canadian Association for Humane Trapping, Humane Canada, and regional humane societies, are all part of such organizations. These organizations have played a vital role in changing public and political attitudes towards the treatment of animals.

Animal rights organizations are against any form of animal use. Such organizations condemn trapping but also hunting and fishing, the use of animals as companions, for food (livestock, dairy, eggs, etc.), or work (e.g., guide or security dogs) (Proulx and Barrett 1991). Most animal rights advocates believe that animals are entitled to the same basic legal rights as human beings (Singer 1975; Regan 1985). Organizations such as Coalition to Abolish the Fur Trade (2018), Animal Defense League of Canada (2021), Animal Rights Coalition (2021), PETA (2021), and many more argue that all forms of trapping are obsolete, cruel, and unnecessary for wildlife management or human requirements.

Compassionate conservation, consequentialist conservation, and animal welfare

Compassionate conservation is an interdisciplinary field which promotes the treatment of all wildlife with respect, justice, and compassion (The Centre for Compassionate Conservation University of Technology 2019). With the guiding principles of first, do no harm, individuals matter, inclusivity, and peaceful coexistence, compassionate conservation aims to find solutions for conservation practitioners that minimize harming wildlife. Using these guideline principles, wildlife management and research programs encompassing the capture, handling, killing, or translocation of animals may not be acceptable (The Centre for Compassionate Conservation University of Technology 2019). Hayward *et al.* (2019) and Beausoleil (2020) pointed out that, while compassionate conservationists favour non-invasive and non-lethal strategies for achieving conservation goals, such strategies may not be adequate to address conflicts that are detrimental to people or other animals, or when non-harmful ways of avoiding those impacts are not currently available. Applications of deontology (theory that suggests actions are good or bad according to a clear set of rules and forms of virtue ethics including animal rights and compassionate conservation) to conservation and other human activities have been prominent in opposing animal killing.

The welfare of individuals and the ethical treatment of animals are part of conservation biology (Paquet and Darimont 2010; Brook *et al.* 2015). Also, both wildlife management and animal welfare share similar ethical origins in that both have been traditionally underpinned by consequentialist ethics, emphasizing the importance of an action's consequences over other ethical considerations such as moral rules, character traits or rights (Hampton *et al.* 2019). Under consequentialist approaches, contentious actions such as killing are considered ethically permissible if, when compared to alternative actions, they deliver a better

balance of positive versus negative welfare effects (Gamborg *et al.* 2012; Dubois *et al.* 2017, Hampton *et al.* 2019). Animal welfare is incredibly important to conservation but, ironically, compassionate conservation does not offer the best welfare outcomes to animals and is often ineffective in achieving conservation goals (Hayward *et al.* 2019).

The philosophy of compassionate conservationists should not be confounded with the views of wildlife professionals who have expressed their concerns about undue pain and suffering in mammal trapping. For example, wildlife professionals have expressed their concerns about animal welfare regarding improper trapping regulations (Proulx and Rodtka 2019), unacceptable trapping devices (Proulx *et al.* 2015, Virgós et al 2016), and poor standards (Iossa *et al.* 2007; Powell and Proulx 2003; Proulx *et al.* 2020).

Who is responsible for professional and ethical mammal trapping?

From a political point of view, government wildlife agencies establish rules and regulations relative to fur trapping. At the scientific level, organizations such as the Canadian Council on Animal Care (CCAC; 2003, 2020), the Animal (Scientific procedures) Act in the United Kingdom (Her Majesty's Stationery Office 2006), the American Association of Zoo Veterinarians (2006), the American Society of Mammalogists (Sikes *et al.* 2011), the American Veterinary Medical Association (2013), and the Australian and New Zealand Council for the Care of Animals in Research and Teaching (2017) provide guidelines for the proper use of animals in research institutions. At the international level, trade standards such as ISO (1999a,b) and AIHTS (ECGCGRF 1997) have been established to address animal welfare in trapping, but they have been highly criticized because they are fur trade-oriented standards, which are not representative of state-of-the-art trapping technology, and fail to properly address the welfare of captured animals (Iossa et al 2007; Powell and Proulx 2003; Proulx *et al.* 2020). When everything is considered, professional and ethical mammal trapping has resulted from the commitment of a core group of scientists who have been personally and professionally concerned with the welfare of animals, and trap research and development − see references to researchers who have been involved in the development of trapping devices in Proulx (1999b), Schemnitz (2005), and Proulx *et al.* (2012, 2020) − and concerned citizens who applied pressure on governments to ban unacceptable traps and find alternatives (Stevens and Proulx 2022).

What

Mammal trapping consists of mechanical devices set in a specific way to capture animals. The components of traps and trapping systems, and the parameters used to determine if a trap is adequate or not for the capture of mammals, are complex.

What is mammal trapping?

Mammal trapping corresponds to the physical capture of animals in traps, snares, boxes, nets, or other mechanical devices. It involves the use of:

- *Restraining traps*: devices used to live-capture mammals. These include cage or box traps, foothold traps, foot/leg snare, cable restraints (neck snares with a modified lock design to stop the noose from tightening), and nets (Proulx *et al.* 2012).
- *Killing traps*: devices used to kill mammals. These include snap traps (mousetraps), planar traps, rotating-jaw traps, killing box traps, manual or power killing neck snares, restraining traps set to slide underwater, and submarine traps (Proulx *et al.* 2012).
- *Trapping systems*: trapping devices with all their parts (trigger configuration and mechanism, springs, closing jaws or striking bar, etc.), sets (construction and location), and baits or lures (Proulx *et al.* 2020).

What is an animal welfare performance threshold?

In today's world, where animal welfare is an important issue for the scientific community (Brook *et al.* 2015; Dubois *et al.* 2017) and the public (van Eeden *et al.* 2017), restraining and killing traps should meet the highest animal welfare standards, and trap standards should be raised as developments on trapping

technology allow (Proulx *et al.* 2020). Responsible professionals must strive continuously to improve traps to work more efficiently, more selectively, more humanely, and more safely for both animals and people.

Performance thresholds for killing traps are based on the time period to irreversible loss of consciousness in struck animals. Once consciousness has been lost, animals do not feel pain. The most stringent criterion used to date for the acceptation of killing traps requires that traps render at least 70% of target animals irreversibly unconscious in less than 3 min (Proulx *et al.* 2012, 2020). In the AIHTS standards, traps must render at least 49% of target animals irreversibly unconscious within a time period that changes with species size but is 5 min for the majority of furbearer species (Proulx *et al.* 2020).

Performance thresholds for restraining traps are based on injury-scoring systems, most of which correspond to pathological changes in captured animals (Proulx 1999a). The most stringent criterion used to date for the acceptation of restraining traps requires that traps hold at least 70% of animals for a maximum of 24 h with less than 50 points scored for physical injury, i.e., without severe injuries that could decrease the survival of released animals (Proulx *et al.* 2012, 2020). In the AIHTS standards, performance level is 57% (Proulx *et al.* 2020).

Proulx *et al.* (2020) recommended that performance level corresponds to a minimum number of animals meeting the acceptation criterion. Also, the evaluation criterion for restraining traps should not be based on mean cumulative injury scores as in White *et al.* (2020), because mean scores are affected by extreme individual values; in other words, many low values can mask the presence of an unacceptable number of high injury scores. While a minimum performance of 70% is superior to AIHTS standards, Proulx *et al.* (2020) considered that this minimum performance level was inadequate and should be further improved. New international trapping standards are currently proposed to meet state-of-the-art trapping technology and improve animal welfare in captured animals (Proulx *et al.* 2022). With these new standards, killing traps should render at least 85% of animals unconscious in less than 90 sec for mid-sized mammals, and less than 30 sec for small mammals (Proulx *et al.* 2022). Standards for restraining trap systems also include new performance criteria including physiological and behavioural changes caused by trapping (Proulx *et al.* 2022).

What is capture efficiency?

Capture efficiency is the rate at which a trap catches a target species, and is usually expressed as the number of captures/100 trap-nights. A trap-night is 1 trap set for 1 night. Trap testing in the field may involve comparing the capture efficiency of test traps to that of control traps, i.e., most popular traps among trappers of a region (e.g., Barrett *et al.* 1989). Many factors affect trap efficiency, such as trap type, trap set, bait and lure, number of traps per unit area, visitation rate, trappers' experience and trap use learning curve, and environmental conditions (Pawlina and Proulx 1999). Weakened springs (Gruver *et al.* 1996), distorted components (Warburton 1982), and poorly made traps (Linhart *et al.* 1986) also affect trap performance. Further, the species assemblage and relative species abundance in test areas may vary among regions, and some abundant non-target species in a particular region may be more attracted to test traps than control traps, and vice versa, thus biasing the true assessment of capture efficiency (Proulx *et al.* 2020). If traps are located diffusely over large areas, they may be absent from small home-ranges (Gehrt and Fritzell 1996). If males and females have home ranges of different sizes, trap density will affect the sex ratio of captured animals (King and Powell 2007), and when changing resources lead to changes in the sizes of home ranges, capture efficiency changes (Smith *et al.* 1994). Also, males and females often behave differently towards traps and sets (Gehrt and Fritzell 1996). Some animals become trap-shy after initial capture, while others become trap-happy (Pawlina and Proulx 1999). Resident or dominant individuals may intimidate intruders or subordinates with their scent marks, affecting capture rate (Pawlina and Proulx 1999). The development of traps with high performance level must ensure that capture-efficiency is as high as that of control traps to meet the objective(s) of any trapping program.

What is trap selectivity?

ISO (1999a,b) defined selectivity as follows:

Selectivity = Number of captured target animals/total number of captured animals

However, Virgós *et al.* (2016) showed that the ISO definition of trap selectivity is only a simple capture proportion and therefore does not represent trap selectivity. Indices of trap selectivity should be based on algorithms which use estimates of species availability (Manly *et al.* 2002). An example of an appropriate index of trap selectivity is Savage's *W* index, a selectivity index used in different ecological applications related to the selection of resources (Manly *et al.* 2002), which can be expressed as follows:

W = Capture proportion/population proportion

where the numerator alone (*capture proportion*) corresponds to the current ISO index for trap selectivity. The denominator (*population proportion*) is that proportion of the entire population of possible trapped animals (of all species) made up of members of the target species. A value of 1.0 for *W* indicates no selectivity. Therefore, good quality information on species occurrence and their relative abundance is required to determine the selectivity of a trapping device (Virgós *et al.* 2016). The development of traps with high performance level must ensure that these traps are used in highly selective trapping systems to avoid jeopardizing wildlife communities and impacting on the persistence of species at risk.

What are the alternatives to mammal trapping?

In the past, trapping was used to capture mammals and study their distribution, habitats, health, etc. (Powell and Proulx 2003). Unquestionably, mammal trapping has significantly contributed to our understanding of mammal biology (Proulx and Do Linh San 2016). However, the capture of wild animals has the potential to cause injury and to change normal behaviour and physiology (Kreeger *et al.* 1990; Cattet *et al.* 2008; Proulx *et al.* 2012). Today, several non-invasive methods, i.e., methods which do not require the handling of animals, have been developed (Zielinski and Kucera 1995; Long and MacKay 2012; Proulx and Do Linh San 2016). The use of non-invasive methods help implement Russell and Burch's (1959) 3Rs principles − *Replace, Reduce, Refine* − and limit the pain and distress that animals are exposed to in trapping (Zemanova 2020). The following non-invasive methods may be considered depending on the objectives of the research program:

- Tracks: animal tracks may be inventoried in sand, mud or snow (Rezendes 1992; Proulx and O'Doherty 2006; Long *et al.* 2008) to determine the distribution of species at landscape and habitat levels, individuals' movements during different phenological periods, etc.
- Scats, food caches, and bait markers (Poole and Graf 1996; Schwartz and Monfort 2008; Bischof *et al.* 2016; Proulx 2016) to determine animals' distributions, habitats and food habits.
- Hair and skin (Sloane *et al.* 2000; Castro-Arellano *et al.* 2008; Wilson *et al.* 2021) to determine animals' distributions, habitats, and genetics.
- Huts, burrows, dens, and setts (Proulx and Gilbert 1984; Landa *et al.* 1998; Lara-Romero *et al.* 2012) to determine animals' distributions and habitat use.
- Foraging and feeding signs (Vowles *et al.* 2016) to determine species' distributions and habitat use.
- Scent marking and latrines (Kruuk 1978; Mijller-Schwarze and Heckman 1980) to assess the distribution of populations and estimate territory sizes.
- Cameras and videos (De Bondi *et al.* 2010; Huck and Watson 2019; Proulx and Buckland 2020) to assess habitat use and behavioural activities.
- Direct observations and spotlighting (Dixon 2003; Proulx and MacKenzie 2012).
- Questionnaire surveys and web-interface records (Proulx and Drescher 1993, Seiler *et al.* 2004; Aubry and Jagger 2006) to assess distribution, use of habitats, and human-wildlife conflicts.
- Although the collection of roadkills and carcasses from trappers is not a true non-invasive method, carcasses found along roadsides or collected from trappers or hunters, can be used to assess population structure, age and sex ratios, reproduction, genetics, etc. (Roper and Lüps 1995; Robitaille 2017).

Why

Why is mammal trapping necessary?

Mammal trapping is being justified by many explanations ranging from sustenance to health concerns among human populations, and disease prevention and management of animal populations (Proulx and Barrett 1991), to religious beliefs where humans have authority over the animal kingdom (Vantassel 2007), and to crusades to save the world from predators who would attack people, and destroy livestock and game species (Miskosky undated; Rocky Mountain Outpost 2016). Not all explanations are valid, and anecdotal and non-scientific information may lead to a misunderstanding of the role of trapping in today's world.

Trapping is necessary for socio-economic reasons. It is especially important to Aboriginal people as a source of money and food, and for clothing and handicraft (Woods 1986; Stabler *et al.* 1990; George *et al.* 1995). However, enjoyment of the outdoor experience alone is a strong motivation for Indigenous people (Nelson *et al.* 2005) as well as for non-Native people (Dorendorf *et al.* 2016).

As pointed out above, trapping is associated with the harvest of furbearers and the fur industry. Furbearer trapping is not necessary for wildlife populations to persist in their environment (Proulx 1999b). However, some species produce enough animals annually to allow the harvest of part of their populations. This is the case for beaver (*Castor canadensis*) (Patric and Webb 1953; Knudsen 1962) and muskrat (*Ondatra zibethicus*) (Errington *et al.* 1963) whose populations may reach density levels that may cause habitat deterioration. The removal of a portion of the population may actually reduce competition among animals for food and cover, and increase the chances of survival for the remaining population, particularly in winter (Proulx 1999b). On the other hand, even when regulated by wildlife agencies, trapping has had negative impacts on species such as the American marten (*Martes americana*) (Hodgman *et al.* 1994), the fisher (*Pekania pennanti*) (Lewis and Zielinski 1996), the wolverine (*Gulo gulo*) (Mowat *et al.* 2020), the endangered Iberian lynx (*Lynx pardinus*) (Virgós *et al.* 2016), and many other species. For species with low-intermediate resilience to trapping, over-exploitation, coupled with habitat destruction and low prey population levels, may result in extirpation (Banci and Proulx 1999).

Trapping is necessary to control introduced (Hodges and Nagata 2001; Keedwell *et al.* 2002) and native (Stancyk 1982; Burger 1989) predators that impact on species at risk. It is also necessary to control commensal rodents that cause economic damages to crop and livestock producers (Proulx 1997; Bradley *et al.* 2015), such as Norway rats (*Rattus norvegicus*), roof rats (*R. rattus*), Polynesian rats (also called Kiore, *R. exulans*), house mice (Mus musculus), cotton rats (*Sigmodon* spp.) and rice rats (*Oryzomys palustris*), ground squirrels (*Urocitellus* spp.), and pocket gophers (*Thomomys* spp.). Rats and mice may reach very high densities in urban settings (Witmer and Proulx 2010). Trapping often is necessary to control rodent outbreaks that can result in increased cases of rodent-borne disease (e.g., hantavirus) transmission to humans (Rodriguez-Moran *et al.* 1998), and in increased plague outbreaks (Stapp *et al.* 2009; Butler 2013). Trapping may be necessary to reduce encounters between humans and wildlife in urban areas (Smith and Engeman 2002), or to monitor and remove animals from diseased populations (Gunson *et al.* 1978; Rosatte *et al.* 1992; Hawkins *et al.* 2006).

Trapping is necessary for the management and conservation of species. Fur trappers may be employed in wildlife management programs aimed at reducing the size of some populations that are in conflict with human property or activities, or impact on the quality or quantity of habitat resources. In this case, fur trapping may be a management tool used by wildlife biologists to meet their objective. Furthermore, animal carcasses may be studied to learn more about the life history and ecology of species, i.e., the reproductive and physical conditions of the animals, and the age and sex ratios of the trapped populations. Such information is used in the analysis of population trends, which is used to improve and modify fur harvest programs (Proulx and Barrett 1991).

Knowledge on the natural history of mammals, and the status and characteristics of the majority of mammal species, could not have been acquired without the use of trapping. Although alternative methods to trapping exist to study some aspects of the biology of mammal species, trapping is still necessary to study

population dynamics, equip animals with radio-collars, carry out translocation programs, and many other research activities.

Why is mammal trapping controversial?

The continued use of unacceptable trapping devices and the protection of the 'old ways' by trappers and pest controllers are largely the causes of so much controversy in mammal trapping. For example, trappers claim that killing neck snares are humane and quickly kill grey wolves (*Canis lupus*) (Rocky Mountain Outlook 2016), in spite of 40 yrs of scientific findings proving that these antiquated trapping devices cause pain and suffering (Proulx *et al.* 2015). In fact, Proulx (2018b) showed that canids captured in killing neck snares may spend hours in distress. Trappers continue to support bounty programs for the control of predators (Rocky Mountain Outlook 2016), but decades of scientific assessments have shown that these programs are ineffective in controlling predators, cause undue suffering, are non-selective, and jeopardize wildlife communities (Proulx and Rodtka 2015).

The use of antiquated technology and ineffective wildlife management programs resulted in the denunciation of trapping devices that do not meet any standards such as killing neck snares (Proulx *et al.* 2015; Proulx and Rodtka 2017), glue boards (Mason and Littin 2003), steel leghold traps (Proulx and Barrett 1989), and unselective trapping devices that endanger the persistence of species at risk (Virgós *et al.* 2016). Others have criticized trapping standards (Iossa 2007; Proulx *et al.* 2020) and regulations (Proulx and Rodtka 2019) that cause distress and undue suffering to animals, and predator control and research programs that are unjustified and unethical (Brook *et al.* 2015; Proulx and Rodtka 2015).

When

When should mammal trapping be allowed?

Trapping is a privilege; it is not a right. As stewards of the land and its resources, people should be responsible to sustain the long-term welfare of populations and individuals (Proulx and Barrett 1989, The Wildlife Society 1990; Paquet and Darimont 2010).

I believe that mammal trapping should be allowed when, and only when, the capture of animals will not impact on the persistence of populations and the welfare of individuals. In other words, if traps are unselective and risk to capture species at risk (Virgós *et al.* 2018), trapping should not be allowed. Selectivity should be species-specific − for example, traps that result in the capture of multiple furbearing species that are legal within a jurisdiction during the regulated harvest season (White *et al.* 2020) are not discriminant; they may capture many other non-furbearer species and cause havoc in wildlife communities.

If traps cause severe injuries and stress in restraining traps, or long and painful deaths, trapping should not be allowed (Proulx 2018b; Proulx *et al.* 2020). Acceptable trapping activities should minimize welfare impacts under the following domains: nutrition, environment, health, behaviour, and mental state (Mellor and Reid 1994; Sharp and Saunders 2011).

When will concerns about mammal trapping stop?

It is likely that the issue of animal welfare in mammal trapping will never be resolved conclusively to the satisfaction of all opponents. Even with major progress, some anti-trapping groups will continue to challenge the performance standards of traps and the acceptability of some trapping systems. However, if wildlife professionals, trappers, and governments work together to develop improve trapping systems that are representative of state-of-the-art trapping technology and implement best animal welfare practices in the field, the gravity of issues raised by anti-trapping organizations will be significantly lessened.

Where

Where should mammal trapping occur?

In research, trapping may occur wherever it is necessary to sample populations; it can therefore be conducted in urban and suburban areas with retraining traps, and in the wilderness with either killing or restraining trap systems. Fur trapping should be limited to wilderness areas that are remote from urban and

sub-urban areas (Villeneuve and Proulx 2022), and away from wildlife reserves to allow populations to expand from protected areas into surrounding landscapes (Proulx and Aubry 2020).

Where should we focus our attention in mammal trapping?

As pointed out by Proulx *et al.* (2020), the future of mammal trapping resides in better technology and implementation programs to ensure the wellbeing of captured animals while increasing capture-efficiency and selectivity. This means that new standards must be developed to increase performance thresholds for killing and restraining traps. These standards must include physiological and behavioural parameters to assess the adequacy of trapping systems. Trap assessment, research and development, and implementation of standards must be transparent, under the supervision of scientists with field expertise, and all findings should be published in peer-reviewed scientific journals (Proulx *et al.* 2020), trade magazines, and newspapers.

Finally, the long-term impact of trapping on wildlife populations, particularly those of carnivores, needs to be investigated. For example, trapping reproductive wolves can subdivide existing wolf territories and, thereby, increase wolf densities locally through compensatory reproduction and colonization (Ballard and Stephenson 1982; Brainerd *et al.* 2008; Hayes *et al.* 2003). The long-term effect of such changes on wildlife communities needs to be further investigated. Harvesting not only affects population size but also population dynamics, age structure, sex ratio, spacing, and likely mating patterns and foraging costs (Powell 1994). The level of resilience among species varies greatly, and many populations do not have the capability to recover from a significant reduction in numbers (Banci and Proulx 1999). Therefore, long-term comparative studies should be conducted between non-harvested and harvested furbearer populations to better understand the effects of trapping on population dynamics, structure, genetics and behaviour (Fortin et Cantin 1990; Banci and Proulx 1999; Botha *et al.* 2022).

Discussion

People of all walks of life can trap mammals, and although there is little control on the background of the trappers and the quality of trapping devices used (Proulx *et al.* 2020; Feldstein and Proulx 2022), integrating ethics, performance criteria, and common sense can ensure that trapping will be carried out without impacting on the perseverance of mammal populations, and the integrity of biodiversity and ecosystems (Powell and Proulx 2003). Today, mammal trapping is still necessary and it should be used in years to come, if only to further our knowledge of mammals' evolution, ecology, animal behaviour, physiology, parasitology, and genetics.

The major issue with trapping is the questioning about the necessity of trapping and the controversy surrounding the welfare of trapped animals. This must definitely be resolved through the use of improved trapping standards (Proulx *et al.* 2020, 2022) that would be representative of state-of-the-art trapping technology, and the implementation of effective and ethical research and management programs (Proulx 2018c).

On the basis of my review of the 5Ws of trapping, I believe that a decision process is required to justify mammal trapping (Figure 1). This process would classify trapping activities among 5 categories: sustenance, research, human-wildlife conflict, fur trapping, and wildlife management (Figure 1). While the use of trapping for sustenance among Aboriginal populations is highly justifiable, mammal trapping systems that are representative of state-of-the-art technology should still be employed. Scientific research needs to meet several assessment levels: 1) it must have a protocol that takes into account the scientific method, with an inductive portion that justifies the need for the specific research; 2) there are no alternative methods to mammal trapping to obtain the results sought by the research program; 3) the program is acceptable from an animal welfare point of view, as determined by an Animal Care & Use Committee (a group of scientists and members of the public who ensure that the highest animal welfare standards and robust scientific research are maintained; Canadian Council on Animal Care 2006); and 4) it will employ state-of-the-art trapping technology (Figure 1). Humane-wildlife conflicts may be resolved through

trapping if, and only if, the capture/removal of animals will address the issues at hand (Proulx 2018a). These actions must be focused on the animals causing the problem and the exact location where conflicts occurred. In other words, using trapping in programs such as bounties where the removal of animals is unselective and not aimed at a specific problem (Proulx and Rodtka 2015), is unjustifiable. Fur trapping should be justifiable if: 1) it is selective; 2) it does not impact on species at risk; and 3) it uses only trapping systems that meet the highest standards of animal welfare (Proulx *et al.* 2022). Finally, wildlife management programs involving mammal trapping need to be based on scientific evidence and must exclusively use trapping systems that meet the highest standards (Proulx *et al.* 2022). The common denominator for all these mammal trapping categories is the necessity to use state-of-the-art trapping technology and species-selective trapping systems (Proulx *et al.* 2022). If only these trapping systems are allowed on the market and on traplines, the justification process (Figure 1) will be easily used and enforced, and the concerns of the public and the scientific community relative to the necessity of trapping and the welfare of trapped animals could be reduced.

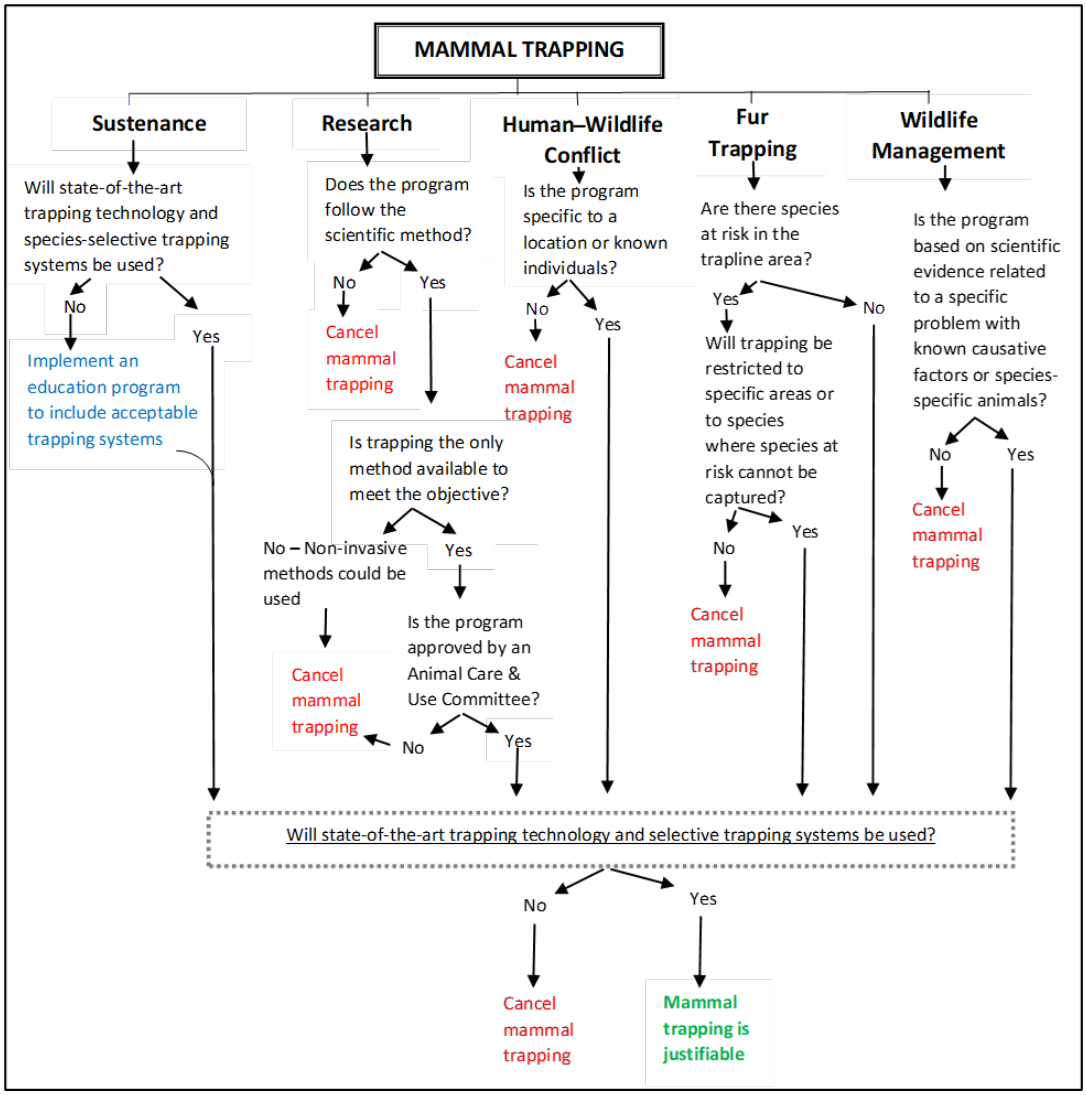

Figure 1. Decision process that may be used to justify the use of mammal trapping.

Acknowledgements

I thank Pauline Feldstein, Don Mitton and Carol Tracey for their comments on an earlier draft of this manuscript.

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