Ranking the Negative Impacts of Wildlife Control Methods May Help to Advance the Three Rs

Ngaio J. Beausoleil [1], Penny Fisher [2], David J. Mellor [1], and Bruce Warburton [2]

[1]Animal Welfare Science and Bioethics Centre, Massey University, Palmerston North, New Zealand;
[2]Landcare Research, Lincoln, New Zealand

Summary

Systematic evaluation and ranking of the negative animal welfare impacts associated with wildlife pest control methods may allow directed application of the Three Rs to reduce welfare compromise in study animals, extension of successful mitigation strategies to field use of the methods, and selection of preferred control methods. A comprehensive literature review on vertebrate toxic agents (VTAs) used to control mammalian pests in New Zealand provided information on the following: mode of toxic action; description of effects; time to loss of consciousness/death; and details of human poisonings. This information was used to evaluate impacts in each of five domains of potential animal welfare compromise according to an established methodology. This analysis revealed the following for a range of VTAs: the level of current knowledge of negative affective experiences caused in different species; gaps in understanding of such experiences; possible ways to identify those experiences; and questions about whether their severity can be judged. At present, application of the Three Rs to VTA studies would be hindered by uncertainty regarding consciousness. In particular, information on the period from the onset of symptoms to loss of consciousness, indicative of the duration of negative experiences, is inadequate. In addition, the level of consciousness during critical events such as convulsions and respiratory compromise is poorly understood. Suggestions are made regarding future research directions and approaches to fill knowledge gaps that will allow more accurate evaluation of welfare impacts and enhance the application of the Three Rs.

Keywords: animal welfare assessment, pest control, vertebrate toxic agents

1 Introduction

The welfare of individual animals can be compromised during wildlife research and when scientific practices are applied in the field. One important aspect of wildlife science and management is the control of pest organisms; such control is undertaken for various reasons including to reduce economic losses, to minimize disease transmission, and for conservation purposes (Littin and Mellor, 2005). In New Zealand, pest control is particularly important because of the unique endemic fauna present and the ongoing dramatic reduction in native populations due to competition and predation from introduced mammalian species (Littin et al., 2004).

In New Zealand, mammalian pest animals are commonly controlled using various lethal vertebrate toxic agents (VTAs). It is acknowledged that these methods have the potential to compromise the welfare of pest animals (Littin et al., 2004; Littin, 2010). However, although the welfare impacts of some individual VTAs have been assessed (e.g., Eason et al., 1998; Gregory et al., 1998; Littin et al., 2000, 2002), and research aimed at improving the humaneness of several VTAs is ongoing (Littin et al., 2004; Marks et al., 2009), there are few, if any, published comparisons of their relative effects.

Systematic evaluation of negative welfare impacts is the first step to successful application of 3Rs strategies. It is necessary first to identify potential and actual negative welfare impacts associated with scientific procedures to guide the development of targeted mitigation strategies and to evaluate the success of such strategies for reducing welfare compromise in research animals (Mellor, 2012). Successful mitigation strategies may then be implemented during field use of the control methods. In addition, ranking the relative impacts of various pest control methods will allow selection of the "most humane" method for use in the field, i.e., the one with the lowest negative impacts on welfare.

The purpose of this paper is to briefly outline general principles derived from a systematic evaluation of negative welfare impacts associated with VTAs used in New Zealand as they relate to the development, application, and evaluation of the 3Rs in wildlife science.

2 A model for systematic welfare assessment

Welfare impacts associated with VTAs used in New Zealand were systematically evaluated using a recently developed assessment model (Sharp and Saunders, 2008). This model is based on the "Five Domains of Potential Welfare Compromise" framework, developed by Mellor and Reid (1994) and subsequently updated (Mellor and Stafford, 2001; Williams et al.,

2006; Mellor et al., 2009). Additional modifications were made to the Sharp and Saunders model before its application in the current research (see below).

According to this framework, potential or actual welfare compromise is identified in four physical/functional domains and one mental domain (Fig. 1). Briefly, when considering a procedure or situation, researchers use their knowledge and relevant literature to describe the potential compromise relating to: nutrition, the animal's environment, its health or functional status, its behavioral needs, and its overall mental state. Actual impacts in the four physical domains are evaluated by assessing quantitative changes in behavior, physiology, and neurophysiology, including cognitive brain function, along with pathophysiological indicators of functional disruption (Mellor et al., 2009).

Compromise in one or all of the physical domains is used to infer potential negative impacts in the fifth domain, as shown in Figure 1. Mental states detrimental to welfare (domain 5), which arise due to compromise in domains 1-4, may include negative experiences such as pain, breathlessness, sickness, dizziness, fear, anxiety, and others (Mellor et al., 2009; Mellor, 2012). It is important to note that an animal must be capable of consciously experiencing negative affective states associated with physical/functional disruptions for its welfare to be compromised (Mellor et al., 2009). One of the main benefits of this framework is that it provides a means of clearly separating physical or functional impacts on the animal (domains 1-4) from the emotional or affective experiences, mental states, or feelings (domain 5) that ultimately determine its welfare. For more detailed information on this model and its application, see Sharp and Saunders (2008) and Beausoleil et al. (2010).

To improve the suitability of the model for assessing VTAs, the original was modified somewhat before conducting the analysis. Key among these modifications was the agreement to score functional impairments only to the point at which consciousness was irreversibly lost; as noted above, after this point, welfare can no longer be compromised. In addition, some changes were made to the original terminology to clearly differentiate functional impacts in domain 3 from negative affective experiences in domain 5 (Fig. 1). See Beausoleil et al. (2010) for further detail of these amendments.

In order to systematically evaluate welfare impacts of VTAs, we began by making a thorough search of the literature, looking specifically for information on: mode of toxic action, toxic effects (using behavioral, physiological and pathophysiological indicators), time to loss of consciousness and/or death, reports of symptoms, and self-reported experiences from human poisonings. Using this information, a panel of experts in animal welfare science, pest control, and veterinary toxicology applied

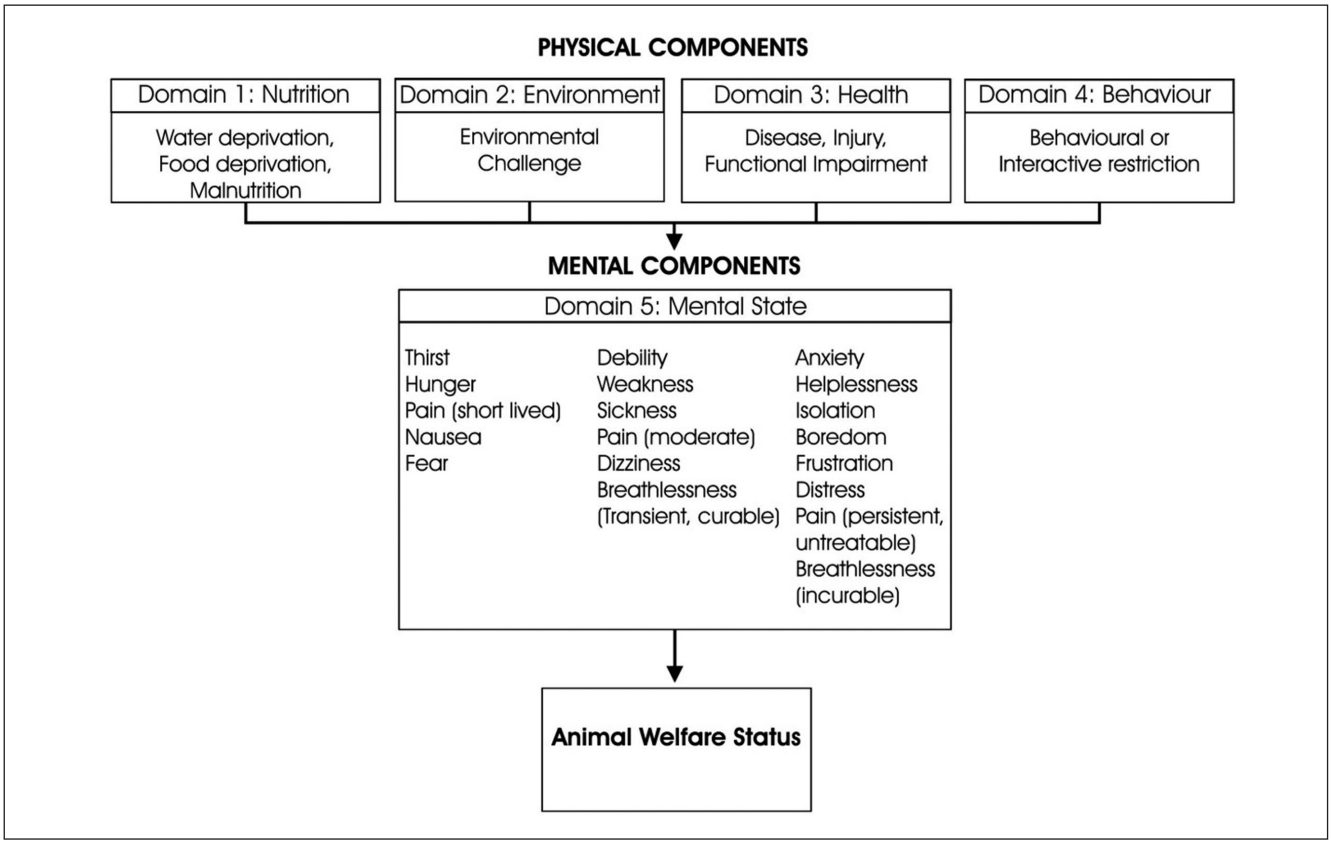

Fig. 1: Domains of potential welfare compromise divided into physical and mental components, the integrated effects of which give rise to the welfare status of the animal
Diagram modified from Mellor et al. (2009).

Sharp and Saunders' model to systematically evaluate welfare impacts associated with various VTAs. The panel assumed best practice with regard to VTA application, i.e., lethal dosing.

Impacts in each of the five domains were evaluated for each toxicant for each of the target and non-target mammalian species (Tab. 1). The overall impact of a particular toxicant was usually that scored in domain 5, as these mental experiences are most directly relevant to the animal's welfare (Mellor et al., 2009). An "overall grade" for each VTA and species was derived by integrating estimates of the "overall impact/severity," which could range from "no impact" to "extreme," and the duration for which the impact was experienced by the animal. From these overall grades, we produced a ranking of the relative welfare impacts of the toxicants for each species.

3 General findings

The analysis outlined above revealed several principles important not only to evaluations of studies of pest control methods and their subsequent use in the field, but also to the systematic assessment of animal welfare and the application of the 3Rs in wildlife science in general. The use of a systematic procedure can highlight the information necessary to conduct a comprehensive assessment of potential welfare impacts. Such analyses reveal the required information that is currently available and sufficiently detailed for understanding negative mental experiences relevant to welfare, as well as the information currently lacking. Also, such systematic evaluation may suggest methods for acquiring the necessary information.

To illustrate: it was considered valuable to provide the readers with an indication of the degree of confidence the panelists had in the data upon which the impact scores were based. Therefore, associated with the "overall grade" for each toxicant was a "confidence score." These scores ranged from 0, reflecting no available animal data with possible negative experiences inferred from human poisoning reports, to 3, high confidence. These scores are considered useful for differentiating procedures confidently ranked as having intermediate welfare impacts from those which were intermediate in the relative rankings because of uncertainty about the impacts or variance among panel members' scores. As such, they represent a caveat on interpretation of the tentative "overall grades"

Tab. 1: List of vertebrate toxic agents (VTAs) used in New Zealand and the relevant target and non-target mammalian species for which literature was reviewed

Primary non-targets are those that may ingest baits containing VTAs. Secondary non-targets are those that may ingest VTAs by consuming other poisoned animals. Taken from Beausoleil et al. (2010).

		Non-target species	
VTA	**Target species**	**Primary**	**Secondary**
Sodium fluoroacetate (1080)	Possum Rabbit Rat Cat	Pig Deer Wallaby	Ferret Stoat
Cyanide (NaCN and KCN)	Possum Wallaby		
Cholecalciferol	Possum		
Brodifacoum	Possum Rat Mouse		Ferret Stoat Cat
Diphacinone	Rat Mouse Ferret		
Pindone	Possum Rat Rabbit		
Phosphorus	Possum Rabbit	Pig	
Zinc phosphide*	Possum		
p-aminopropriophenone (PAPP)	Stoat Cat		
Sodium nitrite*	Pig		

* VTA not yet registered in NZ

presented, as well as allowing readers to rapidly identify areas requiring additional research.

4 Specific findings

With regard to the welfare impacts associated with the use of VTAs on mammalian pests in New Zealand, the use of the Five Domains model allowed identification of physical/functional disruptions that would be expected to cause negative mental experiences if the animals were conscious. However, the assessment also revealed that information essential to understanding the severity and duration of these mental experiences is currently lacking for some VTAs e.g., 1080, phosphorus, PAPP (see Tab. 1). In particular, there is insufficient information available on the period from the onset of physical/clinical symptoms to the point at which consciousness is lost. This period indicates the likely duration of negative experiences that may compromise welfare. In addition, the level of consciousness during critical events, such as convulsions and respiratory impairment, is poorly understood. Without this information, we were unable to evaluate the severity of negative experiences such as breathlessness, pain, and fear that may be associated with such events (Mellor, 2012).

The analysis allowed us to confidently identify the current "best" (lowest welfare impacts: cyanide) and "worst" (highest welfare impacts: anticoagulants, cholecalciferol) VTAs. However, as noted above, the lack of necessary information precluded discrimination among the other VTAs evaluated. Therefore, we conclude that, at present, the application of the 3Rs to studies of some VTAs and their field use is hindered by uncertainty about potential welfare impacts. This limitation is due to uncertainty about the conscious experience of physical/functional impacts in various domains. Future research should aim to elucidate practical indices of the presence of consciousness, or the loss thereof, in the species under study and the use of these indices to evaluate the time to loss of consciousness, as well as the level of consciousness during events that would be unpleasant if consciously experienced.

5 Conclusions

Systematic evaluation and ranking of the negative animal welfare impacts associated with wildlife pest control methods may allow directed application of the Three Rs to reduce welfare compromise in study animals, extension of successful mitigation strategies to field use of the methods, and selection of preferred control methods. The systematic evaluation of the welfare impacts associated with VTAs used in New Zealand to control mammalian pests revealed several general principles applicable to welfare assessments for the purpose of 3Rs applications. The analysis highlighted the information necessary to undertake a comprehensive welfare assessment. Of that necessary information, we clarified what was currently available and what was lacking, and areas for future research were highlighted. Specifically, for the use of VTAs on mammalian pests, we found that for some VTAs there is currently insufficient information available to draw conclusions about the mental state of the animals during physical/functional impacts likely to be unpleasant if consciously experienced. We conclude that the application of the 3Rs to studies of some VTAs and their field use is presently hindered by uncertainty about potential welfare impacts. Future research should aim to fill the existing gaps in the knowledge necessary to conduct comprehensive assessments of negative welfare impacts. This will facilitate targeted application of 3Rs strategies both in research and field use of scientific procedures involving wildlife.

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Correspondence to

Ngaio Beausoleil
Institute of Veterinary, Animal and Biomedical Science
Massey University
Private Bag 11-222
Palmerston North 4442
New Zealand
e-mail: N.J.Beausoleil@massey.ac.nz