Animal welfare in vertebrate pest management and research in New Zealand

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Pest animals have negative impacts on things that people value such as health, food production and biodiversity. Invasive vertebrate species introduced to New Zealand and Australia are no exception, and the serious and widespread threats they present in these environments are currently addressed by broad-scale control programmes involving a range of control methods. Selection of pest control tools is generally driven by an optimal combination of cost-efficacy and safety to humans, other animals and the environment. Lethal control tools such as trapping and poison baiting are used on a worldwide scale against a range of sentient species designated as "pests", and this affects the welfare of large numbers of target animals, and sometimes non-target animals also. Application of both lethal and non-lethal pest control tools raises some specific questions around animal welfare, such as how humaneness is weighted as a criterion in selection of pest control tools and how humaneness is best measured in this context. Increasing community expectations and regulatory requirements that pest control methods meet some (often undefined) standard of humaneness present considerable scientific, technical and ethical challenges—to those currently implementing vertebrate pest control management and also to those seeking to develop more effective, target-specific and humane pest control tools. We outline the rationale behind current research directions in New Zealand that incorporate consideration of pest animal welfare based on assessments of the relative humaneness of pest control tools.

Vertebrate pest control in New Zealand

Introduction of exotic species to naïve ecological or production systems is a common theme in human history (e.g., Lodge 1993). In particular, the relatively recent changes wrought by the establishment of invasive animals in Australia and New Zealand have been rapid and appreciable, being documented in written and living memory (e.g., Low 1999). European colonisation of Australia and New Zealand saw both deliberate and accidental introductions of a common suite of highly adaptable species, including rats (*Rattus norvegicus, R. Rattus*), house mice (*Mus musculus*), rabbits (*Oryctolagus cuniculus*) , cats (*Felis catus*), pigs (*Sus scrofa*) and goats (*Capra hircus*) that have since become widespread pests in both countries (King 1990). The mammalian fauna of New Zealand was further expanded by the introduction of species native to Australia, such as wallabies (*Macropus* spp.) (Warburton & Sadleir 1990) and brushtail possums (*Trichosurus vulpecula*) (Cowan 1990).

New Zealand's indigenous biota (which evolved in the absence of terrestrial mammals) and its agricultural economy are highly vulnerable to the impacts of these introduced species (Hackwell & Bertram 1999). This has resulted in the development of control programmes that target large areas, frequently exceeding 10,000 ha, and do so repeatedly to ensure that the

benefits are sustained. While some forms of non-lethal pest control methods are available, very large numbers of a range of sentient vertebrate species are subject to lethal control such as poison baiting, shooting and trapping. Because of their impacts as vectors of bovine tuberculosis and browsers and predators of native biota, possums predominate New Zealand pest management efforts through the broad-scale application of trapping and toxic baits (Montague 2000). Rodents (commensal and field populations) and mustelids (stoats *Mustela erminea* and ferrets *M. furo*) are also subject to broad-scale control in New Zealand, using a range of toxic baits and kill-traps. Measuring and regulating the welfare of pest animal species, most of which are companion animals or livestock in other contexts, poses unique challenges to researchers and on-ground managers, both in New Zealand and worldwide.

Pest animal welfare and humaneness of control methods

Managers usually have a range of lethal and non-lethal control methods from which to choose when targeting different pest animal species. Selection and implementation of control methods has traditionally been based on considerations of cost-efficacy, target specificity, human operator safety and minimised risk of environmental contamination, and there have been increasing regulatory requirements for data that demonstrate these qualities (e.g., Jacobs 1992). In New Zealand, pest control is exempted from the Animal Welfare Act, although the Act also specifies that anything that falls outside "normal" hunting or killing practices and is considered to cause unreasonable or unnecessary pain or distress could be considered unacceptable (Littin & Mellor 2005). However this leaves considerable scope for interpretation of what might be considered an unacceptable method of pest control. In the current Australian context of pest animal control, Thiriet (2007) contends that 'inadequate legislation, unenforceable codes of practice and negative community attitudes contribute to legalised acts of cruelty against unpopular animals', highlighting the difficulties inherent in defining and implementing "good welfare" for pest animal species (Sharp & Saunders 2008).

Consideration of pest animal welfare is implicit in formulating ethical approaches to vertebrate pest management (Littin & Mellor 2005). Ethical approaches to managing pest impacts include the need for clear justification of the means and ends (i.e. the how and why) (Warburton 2008), and also the need for monitoring outcomes and benefits of control programmes (Littin et al. 2004). Various authors have addressed how pest animal welfare and social perceptions might be balanced against the various control measures deemed necessary for cost-effective, target-specific protection of ecological or agricultural production values (e.g., Hickling 1994; Fisher & Marks 1996; Gregory 1998; Marks 1999; Warburton & Choquenot 1999).

The "welfare impact" of vertebrate pest control expresses the humaneness of control methods used for controlling estimated numbers of animals of particular species. Humane vertebrate pest control has been defined as 'the development and selection of feasible control programmes and techniques that avoid or minimise pain and suffering to target and non-target animals' (Sharp & Saunders 2008). Perceived humaneness contributes significantly to the social acceptability of pest management (Littin & Mellor 2005): for example, a majority (88%) of the New Zealand public felt that lethal pest control methods should meet some minimum standard of humaneness (Fraser 2001). Because of varying perceptions of what is humane, and uncertain measures of what constitutes pain and suffering in wild animals (Kirkwood et al. 1994), defining a minimum acceptable standard of humaneness becomes at least a partly subjective exercise. In the absence of any standard, there are challenges in differentiating the pain and/or suffering caused by different pest control methods to provide an assessment of their humaneness relative to each other. Furthermore, any attempt to assess the absolute humaneness of control methods is complicated by the experimental or management context in which the control method is used. While it may be possible, with good animal husbandry, to create an environment for animals in captivity that presents little or no suffering, animals in the wild face considerable suffering (e.g., disease, injury, starvation, drought, cold) throughout their lives, and most die an unpleasant death that is often prolonged. Thus, as argued by Warburton and Choquenot (1999), it is unrealistic to use the laboratory context of 'no suffering' as a baseline for measuring the absolute humaneness of a control method when its use in the field must be compared with a much higher baseline of "natural" suffering.

New Zealand research related to pest animal welfare and humaneness

Ongoing research in New Zealand includes work around defining measures and standards of humaneness for evaluating currently available control tools, particularly kill-traps and vertebrate pesticides, and developing new control tools with demonstrably improved humaneness. Before 1996 no research in New Zealand made specific consideration of the humaneness of vertebrate pesticides, and up until 1998 welfare research in New Zealand had been almost exclusively on the possum (Eason et al. 1998). The welfare impacts of traps and poisons on mustelids, rodents and cats are now also included in research efforts. There are polarised opinions relating to particular vertebrate pest management practices in New Zealand and Australia, for example use of the poison 1080 (sodium fluoroacetate) is controversial and has come under scrutiny from an animal welfare perspective (e.g., Cooper et al. 2007; Sherley 2007). Low public approval of 1080 is, in part, due to the perception that it is inhumane (Wilkinson & Fitzgerald 2006), and this has prompted calls in New Zealand to have this important control tool banned. The use of leghold traps is also controversial from an animal welfare perspective (Warburton 1998). Thus, for maximum benefit, research in the area of pest animal welfare should recognise stakeholder and public opinion about what is an acceptable level of humaneness of control methods, and what welfare impacts on pest animals are justified in obtaining the benefits of pest control.

Particular ethical issues raised by vertebrate pest research present challenging and confronting questions for animal ethics committees and researchers alike. Disparity in popular perceptions of different groups of animals—e.g., wild versus domestic animals, or 'native good, exotic bad' (Low 2007) means that correspondingly different values are often placed on their welfare. For example, poisoning deer (as pests) was considered unacceptable by a majority people, but fewer people considered poisoning rodent pests was unacceptable (Sheppard & Urquhart 1991). Mason & Littin (2003) highlight the welfare impacts of a range of control methods currently used for rodent pest control. In particular, the use of anticoagulant rodenticides presents a particular 'welfare paradox' (Paparella 2006) – the large numbers of pest rodents poisoned in this way are affected by haemorrhage with an extended time to death (Mason & Littin 2003). Mortality is the obvious index of the efficacy of kill-traps and vertebrate pesticides, thus dictating the use of lethal end-points in animal research aimed at developing and evaluating pest control tools. While some lethal test protocols (e.g., LD_{50} determination for toxic compounds) have been widely criticised (e.g., Morris & Weaver 2003), they remain essential for some pest animal research, at least until sufficient information has been gathered to develop alternative end-points. Biological control of pest animals is another avenue of investigation that may involve genetic manipulation of organisms, raising issues of philosophy and environmental safety within ethical justification of the research. Current progress in pest mammal research and related policy and practice in New Zealand that incorporates welfare considerations is outlined below.

Welfare performance of traps

In New Zealand, traps are controlled by regulations under the Animal Welfare Act, which may prohibit or restrict the use of traps if they are considered to cause unreasonable pain or distress and if they are unable to be modified to improve humaneness. This has seen the recent prohibition of two types of leghold trap (Lanes-Ace and No. $1^1/_2$ sized leghold) (MAF 2007). Following several decades of growing concern about the welfare of trapped animals, the New Zealand National Animal Welfare Advisory Committee developed guidelines to assess the welfare performance of both kill and restraining traps (MAF). These guidelines specify that for kill traps to be acceptable they must be able to render the target animals irreversibly unconscious within 3 minutes, and for restraining traps there must be no more than about 40% of animals with injuries classified on a scale as moderate or moderately severe. While these specifications do not represent an absolute standard of humaneness they do provide a point from which to conduct consistent screening of available trap types, and then rank relative performance to define a spectrum from "worst" to "best". This has enabled identification of trap models with the best welfare performances against a range of target pest species (possums, stoats, ferrets, rats and cats), and subsequently identify where

improvements to welfare performance can be developed. A criticism of kill traps is that they can never be totally species specific and therefore if they do not kill a captured non-target species quickly there may still be undesirable animal welfare impacts. Target specificity can be controlled to a limited extent by excluding species larger than the target animals by using mesh baffles with appropriately sized offset holes for access. Ground-dwelling animals can be excluded by setting traps above ground level but nevertheless, species such as rats are very difficult to exclude. Consequently, the effectiveness of some traps for killing both the target and non-target species has been evaluated in trials (Warburton et al. 2008).

Relative humaneness of vertebrate pesticides

Withdrawal of vertebrate pesticides such as arsenic and strychnine from use in New Zealand has been partly due to perceptions of poor humaneness (Eason & Wickstrom 2001), but before the 1990s very few studies specifically attempted to measure or compare the welfare impacts of poisons (e.g., Rowsell et al. 1979). In some countries, manufacturers of poisons are required to assess the degree of pain and suffering caused to target species (e.g., Broom 1999), but there are currently no internationally recognised protocols for assessing the welfare impacts or relative humaneness of poisons. Evaluating the welfare impacts of poisons needs to account for complexities in comparing pain or distress caused by different modes of toxic action, species variation in responses to toxicity, and how the effects of the poison on normal metabolic, behavioural and physiological parameters should be interpreted as welfare compromise. Time to unconsciousness is an important indicator of the duration of potential pain and distress during poisoning. However it does not provide an indication of the degree of pain or distress that might be experienced by a poisoned animal before loss of consciousness. Building on proposed approaches to assessing pain and suffering in wild (pest) animals (Kirkwood et al. 1994; Sainsbury et al. 1995; Broom 1999), Littin et al. (2002) described an approach to assessing welfare impacts of poisons that incorporates (i) consideration of the capacity of the species to suffer; (ii) anticipation of likely effects of the poison; (iii) determination of the type, intensity and duration of effects and the percentage of animals affected; (iv) determining the degree of welfare compromise caused by each effect; and (v) combining these factors as a measure of the humaneness of the poison.

This approach (or elements of it) has been adopted in relative assessments of poisons used in New Zealand for possum control (O'Connor et al. 2000), including cyanide (Gregory et al. 1998), brodifacoum (Littin et al. 2002) and phosphorus (O'Connor et al. 2007). In possums poisoned with potassium cyanide, the average time to loss of consciousness as 6.5 min, with a time to cessation of breathing of 18 min (Gregory et al. 1998), making it relatively the most humane poison currently used for possum control. On this basis efforts are being made to extend applications of cyanide to effective and humane control of some other pests such as wallabies (Eason et al. 2008). However cyanide use is not effective or practicable for all pest species, and research is also under way towards development of new toxins with improved humaneness and target-specificity.

Assessment of the relative humaneness of the various toxins used in New Zealand for the control of rodents (1080 and anticoagulants), rabbits (1080 and pindone) and mustelids remains to be completed in each of these target species to provide a basis for comparison with newly available toxins. Ongoing work is planned to refine a response-to-stimulus scale as an indicator of the degree of consciousness, and to investigate other physiological parameters and species-specific indicators of pain and distress during poisoning. The possibility of improving the humaneness of currently used toxins such as 1080 through the inclusion of orally active analgesics (Marks et al. 2000; Jongman 2001) or other drugs in baits for possums, rodents or mustelids is another avenue of research being considered.

Fertility control

Fertility control of possums is regarded as a more humane and publicly acceptable alternative to current lethal control tools, particularly toxins (Fitzgerald et al. 2000; Morris & Weaver 2003). Advantages include that animals would not suffer but die from natural causes and that decreasing the amount of toxins used would reduce the risk of environmental contamination and impacts on non-target wildlife. Research aimed at developing immunocontraceptive vaccines

for possums has been under way in New Zealand for more than a decade (Cowan 2000). A range of possum proteins with key roles in fertilisation, embryonic development, and hormonal control have been shown to be effective, and in some cases marsupial-specific, in injectable fertility control vaccines. Several of the immunocontraceptive antigens are currently being incorporated into non-living vaccine delivery systems for dissemination in baits and in the longer term may potentially be developed into vectored fertility control vaccines (Duckworth et al. 2006).

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