Commentary

Towards a Knowledge-Based Ethic for Lethal Control of Nuisance Wildlife

B. WARBURTON,[1] *Landcare Research, P.O. Box 40, Lincoln 7640, New Zealand*

B. G. NORTON, *School of Public Policy, Georgia Institute of Technology, Atlanta, GA, 30332-0345, USA*

ABSTRACT Managers of nuisance wildlife have to rely largely on using lethal methods until such time as nonlethal techniques, such as fertility control, become universally available for a wide range of species. Unfortunately, use of lethal tools has met with opposition from animal welfare and animal rights proponents. Although research has addressed some of the more tractable welfare concerns (e.g., making traps more humane), less tractable ethical issues associated with the justification of killing wildlife remain unresolved. Monistic welfare models or rights-based models have been proposed as ways of addressing these issues, but those that concentrate on the cognitive and conative capabilities of individual animals fail to resolve the ecological and social complexities involved in management of nuisance wildlife. Solutions need to recognize and accept the diversity of values (i.e., within a pluralistic strategy) as well as the uncertainty inherent in many of the systems being managed. Thus, when uncertainty is high in managing wildlife–resource systems, we propose the only ethically defensible action is to apply a knowledge-based ethic that ensures future actions will be carried out with increased understanding. Such an ethic can be made functional within an adaptive management framework that has, as its first tenet, the need to learn and reduce uncertainty. Failure to maximize learning in the presence of uncertainty has the potential to result in increased opposition to even soundly justified operations to manage nuisance wildlife.
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Many vertebrate species, especially invasive species, have become pests (i.e., nuisance wildlife) because of real or perceived threats they (both species and populations) pose to biodiversity values (Clout 2002, Lodge and Shrader-Frechette 2003), their impacts on primary production (Rabiu and Rose 2004, Fleming et al. 2006), or their role in maintaining disease(s) in animal or human populations (Dorn and Mertig 2005, Ryan et al. 2006). Management of nuisance wildlife species can include application of nonlethal techniques such as fertility control (Rodger 2003), repellents (Shafer and Bowles 2004), and fencing (Karhu and Anderson 2006), and although much research is being done to find new and effective nonlethal methods, as yet such methods have limited utility. Consequently, management still relies heavily on using lethal control methods including poisons (Morgan 1994, Burrows et al. 2003), traps (Warburton and Orchard 1996, Proulx 1997), or shooting (Choquenot et al. 1999, Mason et al. 2002). These lethal control tools, especially traps, have been the focus of vociferous opposition from welfare and animal rights groups for many years (Loague 1993, Oogjes 2003). In response, considerable international effort has been made to improve the humaneness of the range of tools used (Warburton et al. 2000, Mason and Littin 2003, Shivik et al. 2005). However, even if control methods are improved to address animal welfare concerns, ethical issues remain about whether management of nuisance wildlife is always justified.

For operations that manage nuisance wildlife to be effective (i.e., to achieve the desired response from the resource being protected), the abundance of the target species must be reduced to, or below, levels at which populations no longer cause unacceptable impacts (Hone 2007). However, to achieve such effective management of nuisance wildlife is a complex challenge for land managers, because the relationship between density of the critical species and resource use is often not linear (Nugent et al. 2001), and if control is carried out in the absence of such knowledge, control can be both ineffective and wasteful of control funding. Additionally, wildlife–resource systems often involve multiple species, and single-species control can lead to unpredictable and sometimes perverse outcomes (Norbury et al. 2002, Ramsey and Veltman 2005). If management programs are implemented with a high degree of uncertainty and little understanding of the outcomes, then such programs expose themselves to substantial ethical challenges.

How to ethically evaluate operations that target nuisance wildlife is subject to ongoing debate. Discussions of the topic in environmental ethics have generally been premised on an extensionist, nonanthropocentric ethic that attributes what are usually human moral characteristics to individuals of other species. Prominent among such approaches are utilitarian treatments such as those of Singer (1990), who argues that interests of all sentient beings should be taken into account equally in deciding all questions affecting human or nonhuman welfare. Regan (1997), criticizing Singer's (1990) utilitarianism, argues that all individuals have rights to life, rights against assault, etc. Singer's (1997) utilitarian approach would seem to allow for experimentation on animals, and perhaps destruction of individual animals, provided the benefits of the action outweigh the welfare costs to sentient beings, whereas Regan (1997) rejects any balancing of welfare costs across individuals.

Besides leading to apparent ethical impasses between

[1] *E-mail: warburtonb@landcareresearch.co.nz*

utilitarianism and rights theory, neither of these individualistic ethical approaches seems likely to support actions that managers of nuisance wildlife might find essential and unavoidable. Individual-based philosophies have not been useful when concern extends to situations where populations of wild animals need to be managed and where such management often is to protect a nonsentient resource such as plants (Callicott 1980, Marks 1999). Consequently, several authors have attempted to define an ethical framework for managing nuisance wildlife (Warburton 1998, Eggleston et al. 2003, Littin and Mellor 2005). Hickling (1994) and Marks (1999) highlighted the dilemmas that the individual-based theories do not allow for consideration of the value distinction often made between indigenous and exotic species, do not readily support an action of killing many exotic animals for the benefit of a few indigenous ones, and do not allow for consideration of nonsentient ecosystem components.

ETHICS AND MANAGEMENT OF NUISANCE WILDLIFE

Over the past several decades animal welfare and animal rights advocates have focused their concerns on, and opposition to, many of the lethal tools managers use to control nuisance wildlife (Gilbert 1991, Hadidian et al. 2002, Oogjes 2003). In response to these concerns there has been a continuing effort to improve control technologies to minimize or eliminate welfare impacts (Proulx 1999, Warburton et al. 2000, Short and Reynolds 2001, O'Connor 2004). However, these improvements have focused on the welfare of individual animals and little attention has been paid to whether animals are being subjected to unnecessary welfare compromise because the operations fail to achieve their objectives (i.e., many individuals are killed with few if any benefits). This concern is especially acute when there are predictable, but difficult to quantify, collateral welfare impacts causing morbidity and deaths in nontarget species. Consequently, failure to address this issue has the potential to result in increased opposition to justified management operations against nuisance wildlife and may offend any reasonable ethics of responsibility in the use of wildlife management tools.

Stone (1987) defined moral monism in environmental ethics as any view (e.g., utilitarianism or rights theory) that applies one ethical rule or framework to address all moral problems. We extend Stone's (1987) definition to include all approaches to policy evaluation that apply one approach to the evaluation of policy options. Hitherto, most attempts to evaluate wildlife control options have invoked monistic welfare models or monistic rights-based models, (i.e., models that concentrate all attention on the cognitive and conative capabilities of controlled populations).

In our view, it will be impossible to resolve such complex issues by paying attention to one aspect, such as the suffering or comparative suffering of animals as a result of control activities. As long as values as diverse—and legitimate—as reduction of unnecessary pain and unnecessary killing and protection of biological diversity, production values, and hunting resources are in play in these decisions, no one-dimensional, individually based ethic can adjudicate among the complex and competing social values involved in management of nuisance wildlife. We propose to consider decisions to undertake control activities within a pluralistic framework of values that considers suffering and death of sentient creatures but considers other, competing, values as well.

Control of nuisance wildlife presents a classic example of a wicked problem (Rittel and Webber 1973, Norton 2005). Because interest groups with differing values see the problem so differently, they cannot agree in formulating the problem, much less in solving problems creatively and cooperatively (Allen et al. 2001, Robinson and Whitehead 2003, Bronner 2005, Rikoon 2006). Wicked problems, unlike benign problems that have one definitive answer, defy right–wrong, either–or answers. Wicked problems cannot be formulated as problems of optimization and are not susceptible to computational or algorithmic solutions. Further, wicked problems resist solutions in terms of monistic theories of value, because advocates of theories of value, whether economic or ethical, insist on finding the one right answer—which leads into useless rhetoric, dogmatism, and decision-making gridlock. Because wicked problems involve competing reasonable goals, they have no single, correct solution.

For the foreseeable future, problems of managing nuisance wildlife will remain controversial because entrenched interests (e.g., protection of biodiversity vs. protection of the lives of individual pest animals) frame the problem differently, invoking differing values, and every choice made by managers of nuisance wildlife can be protested from multiple value and scientific perspectives. For this reason, it seems unlikely that controversies over managing nuisance wildlife will be resolved by formulaic applications of monistic theories such as extending rights to all animals or by seeking a bottom-line economic, cost–benefit analysis. Before further addressing these competing normative issues, we explore some of the complexities and uncertainties of these highly contested decisions.

WILDIFE MANAGEMENT SCIENCE

Wildlife–resource-system dynamics can be complex and vary depending on the nature of the interactions between the wildlife population and associated resources (Parkes 1993*a*). For example, some systems may be simple, single-species systems that have density-dependent processes that can be easily modeled and their outcomes predicted (Barlow 1991*a*). In contrast, other systems may have multiple species and density-independent factors influencing the system. Consequently, these systems are more difficult to model and for these it is more difficult to predict likely outcomes from management intervention (Caughley and Sinclair 1994, Choquenot and Parkes 2001, Hone 2006).

Management of nuisance wildlife, therefore, often has a very large component of uncertainty, with outcomes not as expected, either in terms of not achieving the primary goal (e.g., protection of some conservation value) or in producing some perverse outcome (e.g., reduction of one species releases another to cause equivalent or worse impacts; Billing and Harding 2000, Norbury et al. 2002, Steen et al. 2005, Tomkins and Veltman 2005, Vicente et al. 2007).

For wildlife–resource systems that have clear resource objectives and known thresholds (e.g., to eliminate a disease) wildlife managers can often develop control programs that are effective in achieving the desired goals. As an example, bovine Tb (*Mycobacterium bovis*) is the most important disease of livestock in New Zealand, affecting dairy, beef, and deer herds (Coleman and Cooke 2001). The Animal Health Board (AHB; a non–profit-making incorporated society) was formed specifically to manage and implement the National Pest Management Strategy for bovine Tb, with the aim of achieving Tb freedom in New Zealand by 2013 (AHB 2008). Management of the disease requires reduction of the disease within herds, which is achieved by a test and slaughter program, movement control of infected herds, and control of the main wildlife vectors, the brushtail possum (*Trichosurus vulpecula*) and ferret (*Mustela furo*). The AHB spends approximately $50 million (New Zealand currency) annually on vector control, over an area of approximately 9 million ha (AHB 2006). Managers within land-management agencies (e.g., regional councils) develop control programs for their regions taking account of the AHB's disease reduction targets, stakeholder (i.e., farmers, local communities, and interest groups such as hunters) concerns, and any biological or operational constraints. Control of possums is mostly contracted out to private businesses that have the necessary skills for carrying out aerial control operations using 1080 carrot or cereal baits (Morgan and Hickling 2000) or ground-based operations using a range of baits and toxins and traps (Warburton and Montague 2000). Most control contracts are performance-based, and require contractors to reduce possum abundance to below a target level before they are paid. This performance-based system has been able to be implemented for 2 reasons: 1) there is a nationally standardized method for assessing possum abundance that enables managers to determine if contractors have achieved the desired population reductions (Warburton et al. 2004, National Possum Control Agencies 2005) and 2) there is good theoretical (Barlow 1991*a*, *b*; 1993; Barlow et al. 1997; Caley 2006; D. L. Ramsey, Landcare Research, unpublished report) and empirical (Pfeiffer et al. 1995, Caley et al. 1999, Ramsey et al. 2002) evidence for the threshold level to which possums must be reduced to prevent Tb from persisting in the system.

The possum control program managed by the AHB satisfies the 4 requirements for achieving effective and what we believe to be ethically justified nuisance wildlife control: 1) a target threshold for possum population reduction that needs to be achieved to meet their goal, 2) an objective methodology for assessing whether the target reductions have been achieved, 3) effective control tools for achieving those reductions including a performance-based contract system for service delivery, and 4) necessary legislative support to ensure compliance.

In contrast to the possum control program, there are many examples of nuisance wildlife control operations that fail to achieve their desired objectives. Failure generally results from an incomplete understanding of the wildlife–resource system being managed, including 1) incorrect identification of the critical threats (Dilks et al. 2003, Berger 2006), 2) no or incomplete knowledge of the relationship between wildlife density and resource use (Allen and Sparkes 2001, Sweetapple et al. 2002), 3) a lack of understanding of the temporal dynamics of nuisance wildlife and the affected resources (Cote and Sutherland 1997, Pech et al. 2007), 4) a lack of understanding of the spatial responses of nuisance wildlife (Engeman and Campbell 1999, Sullivan et al. 2001, Byrom 2002), 5) a lack of understanding of how sympatric species might respond to single-species control (Murphy et al. 2004, Ruscoe et al. 2006), and 6) ineffective control tools (Billing and Harding 2000). Additionally, failure often results from a lack of sustained commitment of funding because of changes in agency policies and priorities (Parkes 1993*a*, *b*).

Given the multiple reasons why such operations may fail to achieve their objectives and the uncertainty under which most wildlife managers have to operate, there is a substantial opportunity to embrace this uncertainty and learn. Unfortunately, few nuisance wildlife management operations appear to make use of such opportunities.

FAILURE TO LEARN

There are few publications that review how the design of nuisance wildlife control operations may provide information from which robust inferences can be made (Reddiex and Forsyth 2006). Personal experience suggests that many operations are poorly structured in terms of creating opportunities to learn, and this view is supported by Reddiex and Forsyth (2006) who reviewed 1,915 vertebrate pest-control operations in Australia and found most (67.5%) had only one treatment and did not monitor either the target species or the biodiversity response. Only 2.4% of operations had both treatment and non-treatment areas, and only 0.3% had treatments and non-treatments randomly assigned. Replication occurred in only 1.0% of operations.

The inability to learn from most control operations because of lack of experimental discipline, along with evidence that many operations fail to achieve outcomes, suggests management is failing on both fronts (i.e., failing to achieve outcomes and failing to increase knowledge). Further, aside from the often-criticized welfare effects of control operations on target and collateral species, there is an independent—or, perhaps, complementary—argument against many of these operations: managers 1) do not know or have an inability to calculate the net impacts of their actions, and 2) do not act to address this failing.

If nuisance wildlife managers are to address these 2 criticisms their most efficient strategy will be to address the failing to calculate the net impacts of their actions and do so by embedding wildlife management within a broader adaptive management framework in which actions are evaluated not just for their impacts on welfare (human and nonhuman), but also for their ability to contribute to knowledge. This embedding of control operations within experimental adaptive management is necessary at 2 levels. First, because the outcome is often uncertain, even when there is widespread agreement that a given control action should be undertaken, it is therefore important to monitor such outcomes (which may include ecological, technical, animal welfare, or economic factors) so methods and means can be modified in future programs. Secondly, even successful killing of nuisance wildlife may not achieve goals of protecting unquestioned social values, and so the means to achieve the end result may be questioned, some goals identified as counterproductive, and some objectives identified as misguided. Adaptive management can thus address normative goal-setting choices as well as reducing uncertainty, and experimental management can help people to address uncertainty both about outcomes of treatments and program objectives (Norton 2005). As new knowledge of impacts of various treatments is gathered, public discourse may be widened to include an examination and reexamination of collective ethical responsibilities.

Thus the embedding of control operations within experimental adaptive management contains the seeds of a knowledge-based ethic for managing nuisance wildlife, acknowledging that any actions to control wildlife with lethal methods will have welfare costs to animals affected and that, in many cases, positive outcomes carry a risk of failure. Accordingly, ethical action, even if it fails to achieve its primary goal of protecting the social value thought to be at risk, may be justified if it reduces uncertainty, exposes poorly conceived projects to test, and stimulates discussion of social values.

ETHICS AND CONTROL OF NUISANCE WILDLIFE

We are proposing a pluralistic integrated process that encourages learning through adaptive experimental management. The idea underpinning this approach begins with the expectation, implied by the judgment that actions to control nuisance wildlife present wicked problems, and that there will be considerable conflict over values and goals pursued by participants in any discussion of policies and actions. By replacing the monistic approach with a more pluralistic one, it is possible to accept conflict and to transcend that conflict by focusing discussion on the shared value of increased knowledge and understanding.

The one certainty is that public discourse and decision-making about choices to be used in controlling nuisance wildlife will be, for the foreseeable future, carried out amid uncertainty and conflict. What would be some consequences of recognizing, even embracing, that uncertainty? Recognition of uncertainty and ignorance would need to be taken as an opportunity to learn from whatever activities we undertake. This is the first tenet of adaptive experimental management. Thus, whatever specific and substantive values are at issue in any dispute about wildlife management, a knowledge-based ethic will organize any and all control activities associated with managing nuisance wildlife as essentially a scientific process.

We need a fresh start. We propose a broad approach to ethical analysis embedded within an ethic rooted in adaptive experimental management's commitment to learning our way out of difficulties (i.e., learning by doing [Walters and Holling 1990]). To learn from our doing, however, we must practice good science, and our ethic necessarily involves a heavy investment in science (Lee 1993, Gunderson et al. 1995). According to this value approach, we consider each act of controlling vertebrates in relation to its consequences, but consequences as they are characterized by all of the diverse advocates of multiple interests. By affirming pluralism, we attempt not to reduce all social values affected and interests represented to one measure, but rather to identify management goals that will protect the broadest balance of affected social values. Pluralism, although always somewhat messy, has the advantage that multiple competing values are made explicit, which in turn may help participants to reframe issues so as to take more values into account. One potential process for managing such conflicts is a dialogue approach, which has been used to find a way forward for such contentious issues as use of aerial 1080 operations (Hayes et al. 2004).

What may recommend this knowledge-based ethic for managing nuisance wildlife is that it can unite individuals with different perspectives behind the belief that, whatever one's interests and value commitments, knowledge has value. The commitment to increasing knowledge can be thought of as a meta-value, a value that can be endorsed by individuals and groups with different substantive values affected by control activities.

The knowledge-based ethic might be summed up in 2 commitments, which imply strong obligations on the part of policy-makers in this area: 1) state, or define and agree upon, what you are doing at the outset (i.e., do not disturb a system without a hypothesis in mind); 2) When acting in the face of uncertainty, design experimental actions to reduce ignorance of the system and impacts on it. These commitments ensure control actions can be justified provided the existing knowledge base can identify realistic goals and prescribe effective treatments. Even here, actions should be designed with controls and as laboratories to test hypotheses and experiment with treatments.

In complex and poorly understood systems in which vertebrate animals are causing undesirable impacts, animals are often killed without reliable knowledge of the effects of control and collateral impacts. The knowledge ethic would require such control programs to be redesigned to include scientific testing of hypotheses and attempts to learn more about the impact of current projects on the total range of affected values. Attempts to deal with such uncertainty have been made using fuzzy logic that explicitly recognizes the uncertainty of many of the components of the system being managed (Ramsey and Veltman 2005).

A KNOWLEDGE-BASED SOLUTION

Because most operations targeting nuisance wildlife are essentially large-scale manipulations of individual animals, actions of wildlife managers are little different from researchers who also manipulate animals as part of experiments. However, before a researcher can initiate trials that include manipulations of animals, they must first (in most countries) obtain animal ethics committee approval. In contrast, managers of control operations do not need to obtain such approvals even if such operations will manipulate considerably higher numbers of animals than would ever be manipulated within an experiment. Can this disparity be justified? We think not.

On the basis of the ethical approach we suggest, to maximize benefits obtained from implementing an operation to manage nuisance wildlife and to minimize the ethical cost, especially when there is considerable uncertainty, we recommend that all lethal control operations targeting nuisance wildlife be reviewed (perhaps by an animal ethics committee) for appropriate experimental design. We emphasize that it is those operations with high uncertainty that should be dealt with this way, not operations that have been proven to achieve desired outcomes (e.g., the possum–Tb example). Applying an experimental approach will ensure that learning is maximized even if the operation fails to achieve its operational objectives. Such adaptive experimental management has been advocated for addressing uncertainty in ecosystem management (Walters and Holling 1990, Lee 1993, Walters and Green 1997, Norton 2005) and such an approach has been integrated into a Standard Operating Procedure by the New Zealand Department of Conservation.

Because large-scale (operation-based) experiments will have higher costs resulting from increased monitoring and implementation (Walters and Green 1997), we acknowledge that the cheaper option of just killing nuisance wildlife will often be the favored choice of action. Land-management agencies will resist allocating funds to such experimentation because of higher direct costs, risks, and opportunity costs, unless there is a clear net increase in economic benefit. Walters and Green (1997) proposed using an accounting framework based on comparison of expected values or utilities (Raiffa 1968) to objectively determine the net present value of competing hypotheses or treatments. That is, the value of knowledge gained from experimentation is accounted for in terms of expected future management performance (Walters and Green 1997). We note, however, that management of nuisance wildlife will often provide multiple nonmonetary benefits (e.g., biodiversity protection, individual species protection, ecosystem services, carbon storage, and animal welfare) and, therefore, to assume all values can be accounted for within an economic framework may not be appropriate for such systems (Jensen and Sorensen 1998). Walters and Green (1997) recognized some benefits would be nonmonetary and provided a 5-step process for objectively integrating nonmonetary benefits into the valuation process. Walters and Green (1997) also warn of possible risks posed to the valuation process if nonmonetary values are set unrealistically high.

Our discussion of uncertainty, questionable objectives, and ignorance of the true impacts of managing nuisance wildlife suggest the usefulness of a knowledge-based ethic for managing nuisance wildlife. The essential elements of such an ethic are 1) when nuisance-wildlife control programs are proposed with incomplete knowledge of the overall effects, including animal welfare, the program must be reconstituted as a management experiment and administered as an element of an adaptive management system; 2) when facing uncertainty about the effects of controlling nuisance wildlife, act to identify key factors underpinning this uncertainty and explore options for testing these factors to increase knowledge; 3) use new knowledge to update understanding of the system being managed (ecological and social) and to decrease uncertainties; and 4) continue to seek improvements in managing nuisance wildlife that maximize benefits (social, environmental, economic) and minimize costs.

MANAGEMENT IMPLICATIONS

Management of nuisance wildlife that relies on manipulation of sentient animals will continue to be scrutinized by opponents of lethal control and those concerned about animal welfare. If management of nuisance wildlife is to be justified, it is essential that animals are not killed wantonly and that when they are killed this action is part of wildlife management programs that have clearly defined objectives and monitoring and audit procedures.

There will be some immediate implications of imposing ethical rigor onto nuisance-wildlife management programs as well as more long-term implications. In the short-term, management agencies will need to develop a process for evaluating their nuisance-wildlife management plans (as animal ethics committees do for research proposals) and this process, along with compliance with any requirements to structure management as adaptive management experiments, will have additional costs. The process followed in implementing such requirements could initially be voluntary with agencies having in-house standard operating procedures to guide managers in how plans should be developed and reviewed. If the recommended process was to be given more legal weight then the process would have to comply with relevant federal and state legislation, and the details of such regulatory process will varying depending on the country and state.

In the longer term, management should become smarter (i.e., based on increased knowledge) because of more rapid learning, and as a consequence management actions should become more defendable because of the higher probability of achieving successful management outcomes and doing so with reduced ethical costs. For such a process to be successful those involved in managing nuisance wildlife will need to acknowledge and accept that there will be a cost, at least in the short-term. To reduce uncertainty and increase knowledge, management operations should become more effective and efficient, and funds wasted on ineffective management should decline.

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