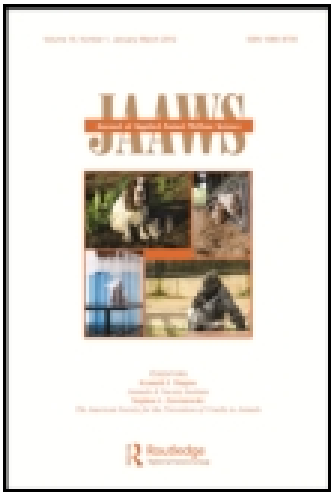

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Understanding Attitudes Toward the Control of Nonnative Wild and Feral Mammals: Similarities and Differences in the Opinions of the General Public, Animal Protectionists, and Conservationists in New Zealand (Aotearoa)

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Understanding Attitudes Toward the Control of Nonnative Wild and Feral Mammals: Similarities and Differences in the Opinions of the General Public, Animal Protectionists, and Conservationists in New Zealand (Aotearoa)

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Lethal control is used extensively in New Zealand to control nonnative nonhuman mammals. Respondents were surveyed about 8 mammal groups considered pests and their attitudes toward their control and pest status. They also identified the most appropriate method of control for the 8 different mammals. Information was gathered from 3 groups of respondents: nonhuman animal protectionists, conservationists, and the general public. Conservationists routinely rated all animal groups as more severe pests than the general public or animal protectionists, who provided the lowest scores. Rats, stoats, brushtail possums, and rabbits were identified as the 4 most serious pests by all 3 groups. Conservationists were 5.7 and 2.6 times more likely to prefer a lethal method of control than protectionists and the general public, respectively. For all 3 groups an increase in pest score for a given animal saw a decline in importance placed upon the animal's welfare. This relationship was strong for the general public but weak for conservationists and animal protectionists. Understanding aspects of potentially opposing viewpoints may be invaluable in supporting the development of new welfare-focused control methods.

Keywords: animal welfare, conservation, feral, introduced mammal, lethal control, nonlethal control, pest

The distinctive elements of New Zealand ecosystems evolved in the absence of mammalian predators (Holdaway, 1989; White & King, 2006). The introduction of various nonhuman nonnative mammals by Māori and non-Māori settlers had significant impacts on components

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of these ecosystems (Clout & Saunders, 1995; Craig et al., 2000). In addition, some of these mammals act as vectors for disease (e.g., Ryan et al., 2006) with potential for substantial economic costs to New Zealand's primary agricultural industries (Clout & Veitch, 2002; Warburton & Norton, 2009). Consequently, both governmental and nongovernmental organizations are engaged in major pest control programs to reduce or mitigate these impacts.

The control of nonnative mammals in New Zealand predominantly involves lethal methods (Warburton & Norton, 2009) and includes trapping, poisoning, shooting, and the introduction of disease (Clout & Veitch, 2002). Nonlethal control methods include the use of cage trapping and release, repellents, and predator exclusion fences (Scofield, Cullen, & Wang, 2011). Reproductive control is currently under investigation (Holland, Cowan, Gleeson, & Chamley, 2008). Different methods of control have the potential to inflict varying degrees of pain, distress, and suffering depending on the duration of effect and mode of action (Littin, 2010).

Public awareness of animal welfare is increasing (Eggleston, Rixecker, & Hickling, 2003; Jordan, 2005; Meerburg, Brom, & Kijlstra, 2008). The acceptability of the impacts of a range of control methods on the welfare of the target species may vary depending on the perceived damage caused by (and economic value of) the species concerned (Littin & Mellor, 2005). The need to assess the acceptability of control programs on nonhuman animals in the wild among the general public and special interest groups has been noted (Bremner & Park, 2007; Decker, Brown, & Siemer, 2001). However, studies have largely focused on those groups that manage wildlife (e.g., Miller & Jones, 2005, 2006). There is a relative paucity of information on those who may traditionally oppose lethal animal control measures.

Both ecological and economic objectives inform decisions around the most appropriate means of pest control (Littin, Mellor, Warburton, & Eason, 2004; Sharp & Saunders, 2008). Increasingly, the impacts of particular pest management protocols on animal welfare are also becoming an integral component of the decision-making process. The relative importance of welfare impacts (encompassing mental and physical well being) of control measures on both pest and nontarget animals (Duncan, 1996) will be affected by local social and cultural values (Sharp & Saunders, 2008).

The extent to which a range of introduced animals is considered pests by the general public in New Zealand has been addressed (e.g., Fraser, 2001). The current study extends this work to consider the extent to which welfare concerns associated with possible control options, for both target and nontarget animals, may vary among different interest groups. It also considers how these differ among a range of nonnative mammal groups. We hypothesized that the degree to which welfare concern, with respect to both target and nontarget animals, dictates the choice of control will be influenced by the extent to which the target animal group is considered a pest. Littin and Mellor (2005) have suggested that the acceptability of control methods, related to the possible impact on the welfare of a target pest species, may be dictated in part by perceived damage caused by the species concerned.

MATERIALS AND METHODS

Attitudes toward the control of nonnative feral or wild animal groups were investigated by means of a survey. Responses were gathered on eight different nonnative animal groups present within New Zealand, namely, brushtail possums (*Trichosurus vulpecular*), cats (*Felis catus*),

rabbits (*Oryctolagus cuniculus*), deer (*Cervus spp.*), horses (*Equus caballus*), rats (*Rattus spp.*), stoats (*Mustela erminea*), and dogs (*Canis familiaris*). The group "deer" represents seven species, and the group "rats" represents three species. This approach was taken as it simplified the questionnaire, and there may be little awareness of the species differences among the general public (see Fraser, 2001), particularly as they relate to control and pest status. It was assumed that respondents with an interest in conservation are likely to appreciate the ecological and behavioral differences between deer and rat species. For example, the Polynesian rat or kiore (*Rattus exulans*) has cultural significance for Māori and is potentially less damaging to some but not all native fauna than the two other species of rats (Hoosen & Jamieson, 2003; Towns, Dougherty, & Cree, 2001). The potential ambiguity that this may cause in categorizing the pest status of these multispecies groups may be partially offset by the common use of rodenticides and kill traps for all species of rats (Gillies, 2001) and shooting for all species of deer (Husheer, Coomes, & Robertson, 2003).

With the exception of dogs, all animal groups are officially listed as "pests" within New Zealand (Littin et al., 2004). Some are common pest species within New Zealand and are frequently reported as such within the media and popular literature (e.g., brushtail possums; Potts, 2009). Others are represented as companion animals who may be strongly associated with human habitation in New Zealand (Aguilar & Farnworth, 2012, 2013) but may also be socially problematic (e.g., domestic cats; Farnworth, Dye, & Keown, 2010) with a potential to impact upon native fauna if not controlled. Finally, some have the potential to be perceived as commercial and recreational hunting resources (e.g., deer; Fraser, 2001) as well as pests.

Sampling

Three different respondent groups were selected on the basis that they were likely to have different views toward the management of vertebrate pests (Littin, 2010). The groups were general public (Group 1), protectionist (Group 2), and conservationist (Group 3). Protectionists were identified as those individuals who belonged to, were employed by, or volunteered for an animal protection or animal welfare charity or were currently studying a curriculum at a tertiary institution that contained courses with titles that included the term "animal welfare." Conservationists were defined on the basis of similar associations with conservation organizations or tertiary-based study of the discipline.

Individuals were canvassed at tertiary institutes, an annual national conference for animal welfare charities and their volunteers, meetings of conservation charities and their members, and agencies concerned with the enforcement or dissemination of welfare- and/or conservation-based information. The survey and its method of dissemination were approved by the Unitec Research Ethics Committee. It was assumed that responses reflected the opinions of the individuals who completed them, and we did not differentiate among the particular organizations with which they were associated.

A total of 450 surveys were distributed (150 to each of the three target groups) between April 2009 and June 2010. A total of 263 were returned. For both the protectionist ($n = 91$) and conservation groups ($n = 81$), surveys were handed out with a freepost return address in places (universities, tertiary education providers, and professional or charitable organizations) or during events (conferences, volunteer days, or society meetings) appropriate to the particular group.

Responses from the general public ($n = 91$) were gathered within Auckland. Greater Auckland is New Zealand's largest urban center containing a third of the national population (Statistics New Zealand, 2011). Every third individual in the central business district or transport hubs passing the researcher was invited to complete the survey and return it directly. If a given individual declined then the next available individual was approached until an answer was obtained. Members of this group were not vetted regarding their interest in conservation or animal welfare issues. An information sheet provided broad definitions of the following terms as taken from the literature: "welfare," encompassing mental and physical well being of both pest and nontarget animals (Duncan, 1996); "pest," an animal who poses a threat to humans, other species of animals, or causes detrimental impacts on the environment (Littin & Mellor, 2005); "wild," those in their original natural state, not domesticated (Department of Conservation, 2006); and "feral," those who live as self-sustaining populations following a history of domestication (Shackleton, 1997).

The only demographic detail requested from respondents was gender. The survey consisted of a series of questions concerning the eight mammal groups. The questions were identical for all animals. An example for brushtail possums is provided in the Appendix. For most questions the response was scored by use of a single mark through a linear rating scale that ranged from *not a pest* (0 mm) to *extreme pest* (100 mm). This methodology was adapted from Wemelsfelder, Hunter, Mendl, and Lawrence (2001) where it was used to rate perceptions of an animal's behavior.

The second question asked respondents to circle which method of control they deemed most appropriate for the animal in question. There was no option for respondents to select that the animal should not be subjected to control. In the final section, respondents were required to identify the important criteria for determining the method of control.

Statistical Analysis

Data on the pest status score of eight animal groups were highly skewed. Consequently, differences among the three respondent groups were tested using nonparametric protocols. Tests were restricted to pest scores combined for all animal groups or all respondent groups, as appropriate. This avoided the problem of inflated Type I error rates that would have resulted if multiple tests had been completed by analyzing each possible combination of animal and respondent groups separately.

Whether frequency of selection of lethal or nonlethal methods of control was independent of respondent group and animal group was tested using three-way log linear modeling. This procedure was followed with separate chi-squared tests to examine two-way interactions as appropriate.

The importance of welfare (target and nontarget organisms) and conservation considerations (for nontarget organisms) in influencing the choice of the preferred control methods for each animal and respondent group was explored using mixed factorial analysis of variance (ANOVA) after reducing the number of potentially interrelated dependent variables using a principal component analysis (PCA). Survey participants were required to score the importance of seven different criteria or variables in determining the method of pest control for each animal group. The PCA was used with a varimax rotation to reduce these potentially interrelated variables to a smaller set of factors. Sampling adequacy was assessed using the Kaiser-Meyer-Olkin (KMO)

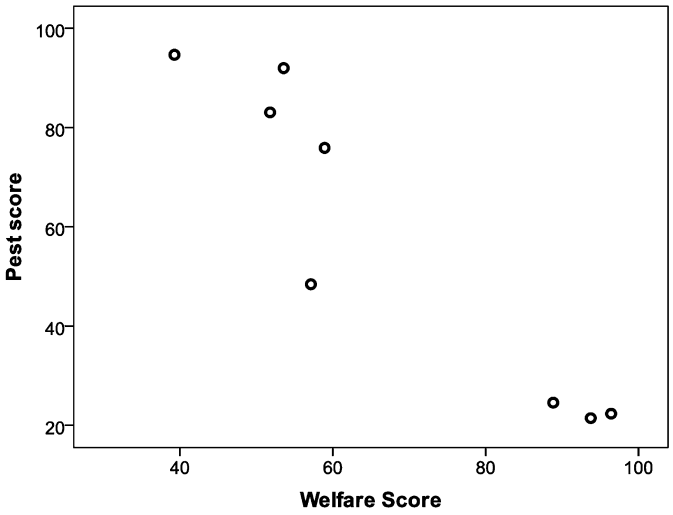

FIGURE 1 Plot of median values of the ratings of the general public with respect to "pest score" and "importance of animal welfare" when considering pest control of a range of introduced mammals ($n = 8$).

measure. Whether correlations between items were sufficiently large for PCA was tested using Barlett's test of sphericity.

Subject to the PCA protocol being deemed appropriate, factor scores based on components obtained from the PCA were then used in a two-way mixed factorial ANOVA to examine the effect of respondent group and animal group on each of the retained components. It is recognized that this may increase the Type 1 error rate; however, the use of PCA restricted the number of variables on which our ANOVA protocols were run to acceptable limits. This also clarified interpretation of the results.

The hypothesis that there may be a relationship between pest score and the importance of animal welfare when selecting a control method was tested for each respondent group using simple correlation analyses. Each data point was generated by randomly selecting, without replacement, a subsample of the total number of respondents. Consequently, each data point (Figure 1) represented the mean median pest score and welfare score of 10 to 11 individual respondents. This approach avoided the potential problem of the lack of independence that would result from the repeated use of the same individuals within a respondent group across all data points.

RESULTS

Gender Distribution

There were significant differences in the frequency of female and male respondents among the three respondent groups (percentage females: general public: 53%, protectionist: 85%, conservationist: 62%; $\chi^2 = 21.972$, $df = 2$, $p < .0001$).

TABLE 1
Effect of Respondent Grouping on Attitudes Toward Pest Status

	General Public (n = *91*)			*Animal Protection* (n = *91*)			*Conservation* (n = *81*)		
Animal	*Pest Score*	*Interquartile Range*	*Rank*	*Pest Score*	*Interquartile Range*	*Rank*	*Pest Score*	*Interquartile Range*	*Rank*
Rat	94	77–98	1	84	61–96	1	96	92–99	1
Possum	90	79–97	2	79	63–91	3	96	88–99	3
Stoat	87	60–97	3	83	64–95	2	96	91–99	2
Rabbit	79	66–94	4	63	46–82	4	88	67–96	4
Cat	49	21–79	5	29	9–62	5	87	64–96	5
Deer	48	17–69	6	26	6–54	6	77	54–92	6
Dog	27	4–51	7	8	2–41	8	50	25–72	7
Horse	15	3–46	8	9	2–22	7	46	15–68	8

Note. The extent to which three groups of respondents consider eight nonnative mammals pests on a rating scale of 0 to 100 (*least* to *most*) is shown. Pest score represents median number. Rank of animal was determined by the difference between lower and upper quartile values where the median value among animal groups was the same.

Pest Status

The differences in median pest scores among respondent groups and between animal groups are described in terms of frequency, median, and interquartile ranges as appropriate (Table 1). Animal groups with higher pest scores (rats, stoats, and possums) tended to show right-handed skew, whereas animal groups with lower pest scores tended to show left-handed skew, and hence these data are not amenable to transformation.

Without exception, the conservationists rated all eight animal groups with a higher median pest score than the general public who in turn rated all animal groups with a higher median pest score than the protectionists (Table 1). These differences were significant (Kruskal Wallis test: $\chi^2 = 201.46$, $df = 2$, $p < .001$).

There was a large degree of agreement in the order in which the three respondent groups ranked the extent to which a particular animal group was considered a pest. Rats were ranked first by all three respondent groups, and brushtail possums, stoats, and rabbits were all in the top four pests across all groups. Horses and dogs were the lowest ranked (Table 1). The pest score for rats, brushtail possums, and rabbits provided by the general public was more closely aligned with that of the conservationists, whereas for dogs, horses, and cats it was closer to the score provided by the welfarist group. The differences in pest scores among the eight animal groups were significant (Friedman's test: $\chi^2 = 1035.29$, $df = 7$, $p < .001$).

Methods of Control

The dominant method of control selected by conservationists for all eight animal groups was always a lethal one (poisoning, lethal trapping, shooting, and introduction of disease) as opposed to the nonlethal options (trap-neuter-release and contraception). Protectionists selected lethal methods of control as the preferred method only for deer, rats, and stoats and had the

lowest percentage selection for lethal control methods overall. The general public only selected nonlethal control methods for cats and dogs (Table 2).

We tested for statistical dependence of respondent group and animal on choice of lethal or nonlethal control techniques using log-linear analysis. The three-way log-linear analysis produced a final model that retained all two-way interactions, that is, Respondent group × Animal group, Respondent group × Preferred control method, and Animal group × Preferred control method. Expected frequencies generated by the model are not significantly different from the observed data, and hence the model is a good fit of the data (likelihood ratio analyses of this model: $\chi^2 = 15.856$, $df = 14$, $p = .322$). The interaction of Respondent group × Preferred control method was significant ($\chi^2 = 259.134$, $df = 2$, $p < .001$), demonstrating that the ratio of indicating a preference for lethal versus nonlethal control measures was different across the three respondent groups.

Conservationists were 5.7 times more likely to prefer lethal methods of control than protectionists but only 2.6 times more likely than the general public group. Similarly, the interaction between animal group and preferred control method was significant ($\chi^2 = 368.196$, $df = 7$, $p < .001$), demonstrating that the ratio of indicating a preference for lethal versus nonlethal control measures was different across the eight animal groups. The biggest difference was between

TABLE 2
Percentage of Respondents Choosing Lethal or Nonlethal Control Methods

	General Public (n = *91*)		*Animal Protection* (n = *91*)		*Conservation* (n = *81*)	
Animal	*Primary Method*	*% Lethal*	*Primary Method*	*% Lethal*	*Primary Method*	*% Lethal*
Rat	Poisoning (59.3%)	85	Trapping—Lethal (39.3%)	75	Poisoning (79%)	97.5
Possum	Shooting (25.3%)	67	Contraception (30.8%)	48	Poisoning (63%)	91
Stoat	Poisoning (40.7%)	78	Trapping—Lethal (45.1%)	63	Trapping—Lethal (66.7%)	93
Rabbit	Poisoning (27.5%)	66	Contraception (29.7%)	48	Poisoning (38.3%)	81.5
Cat	TNR (34.1%)	38.5	TNR (69.2%)	14	Trapping—Lethal (48.1%)	72
Deer	Shooting (64.8%)	69	Shooting (47.3%)	47	Shooting (79%)	88
Dog	TNR (35.2%)	37	TNR (48.4%)	16.5	Shooting (53.1%)	60.5
Horse	Shooting (40.7%)	43	Contraception (48.4%)	21	Shooting (49.4%)	52

Note. TNR = trap-neuter-release. The most frequently selected method of control for each animal across three groups of respondents is shown. The percentage choosing that method is in parentheses. Overall percentage of respondents selecting lethal methods of control (trapping, shooting, poisoning or disease) for a given animal is also provided (% lethal). Following three-way log-linear analysis of the aforementioned descriptive data, preference for lethal versus nonlethal control measures was different across the three respondent groups ($p < .001$), and the interaction between animal group and preferred control method was significant ($p < .001$).

rats and dogs, with participants in the survey 10.8 times more likely to prefer lethal methods of control for rats than for dogs. The significant interaction between animal group and respondent group is a trivial result reflecting the different number of responses by the respondent groups.

The median pest score for each animal was negatively correlated with the corresponding median value for importance of animal welfare when selecting a control method for each respondent group. This relationship was strong for the general public ($r = -0.938$, $p = .001$, $n = 8$) but substantially weaker for both the conservation group ($r = -0.385$, $n = 8$) and the animal protectionist group ($r = -0.219$, $n = 8$). This indicated that, particularly for the general public group, the greater the degree to which an animal was considered a pest the lower the importance placed upon the animal's welfare (Figure 1).

Target Animal and Nontarget Organism Influence on Pest Control Methods

Principal component analyses were conducted on scores for the importance of seven areas relevant to decisions about pest control methods for each animal group. The KMO measure verified the sampling adequacy for the analysis (KMO values for all individual items >0.687). Barlett's tests of sphericity were significant for all animal groups ($p < .001$), indicating correlations were sufficiently large for PCA. Two components had eigenvalues over Kaiser's criteria of 1, and in combination they explained over 69% of the variance for all animal groups. An example of the factor loading after rotation for one of the animals (brushtail possum) is given (Table 3). The first component clearly represented a measure of impact (suffering and welfare) on the target animal. Facor 2 represented a measure of the impact on nontarget organisms (both welfare and biodiversity impacts; Table 3). There were no major deviations in factor loadings for the components for the other seven animals.

TABLE 3
Rotated Factor Loadings and Other Summary Statistics From PCA Analyses for Each Animal Grouping

Question Concerning	*Component*	*Factor 1*	*Factor 2*
Target animal (e.g., brushtail possum)	1. Intensity of suffering for:	**.930**	.084
	2. Duration of suffering for:	**.911**	.151
	3. Welfare of:	**.859**	.027
Nontarget organisms	4. Impact upon:	.275	**.875**
	5. Welfare of:	.295	**.850**
	6. Preservation of native organisms	−.110	**.828**
Public acceptance	7. Public acceptance	.370	.146
	Eigenvalue	3.22	1.74
	% of variance	46.1	24.9

Note. PCA = principal component analysis. Items that cluster on the same component suggest that Component 1 represents impact on the target animal and Component 2 represents impacts or effects on nontarget organisms. Factor loadings above 0.40 are in bold. The components relate to individual questions in the survey that required respondents to score the importance of each of them with regard to impinging on their preferred control method for each animal. Public acceptance did not fit within either factor and was considered independently.

There was a significant effect of respondent group on Factor score 1 (impact on target animal; $F_{(2,260)} = 25.24$, $p < .001$). Pairwise comparisons indicated that protectionists had Facor 1 scores significantly different from those of the general public and the conservationists (both $p < .001$), but there was not a significant difference between the general public and conservationists ($p = .713$). In particular, the protectionists routinely scored Facor 1 (impact on the target species) consistently higher than that of the other two respondent groups when considering the preferred or most acceptable pest control measure (Figure 2). Within respondent groups, no effect of animal group was detected and no interaction effect between animal and respondent group for Facor 1 was found ($p = 1$ and .06, respectively).

Moreover, there was a significant effect of respondent group on Facor 2 score (impact on nontarget organisms: $F_{(2,260)} = 6.754$, $p = .001$). Differences between the general public and the conservationists were significant ($p = .001$). Differences between the protectionists and conservationists bordered on significance ($p = .052$), and there was no significant difference between the general public and protectionists ($p = .372$; Figure 3). Similar to the case for Facor 1, no effect of animal group was detected within respondent groups and no interaction effect between animal and respondent group for Facor 2 was found ($p = 1$ and .423, respectively).

Public acceptance of the control methods (Table 4 respondent group data are combined for clarity) always scored lowest as a factor influencing the choice of control measure for all animal groups (see Table 4). These differences were significant among respondent groups (Friedman test: $\chi^2 = 1631.9$, $df = 23$, $p < .001$).

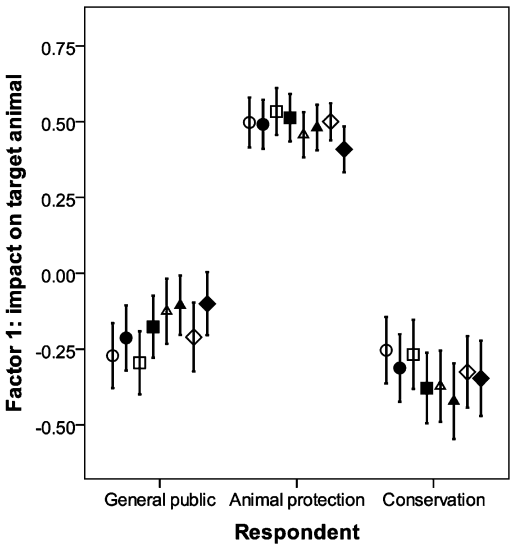

FIGURE 2 Scores from principal component analysis on Factor 1 (impact on target animals) as a consideration in determining primary method of control for all eight animals groups for each of the respondent groups. Error bars are mean ± 1 *SE* (○: rat, ●: possum, □: stoat, ■: rabbit, △: cat, ▲: deer, ◇: dog, and ◆: horse). The Factor 1 score of the animal protectionist group is significantly different when compared with the other two groups ($p < .001$). General public and conservation are not significantly different ($p = .713$).

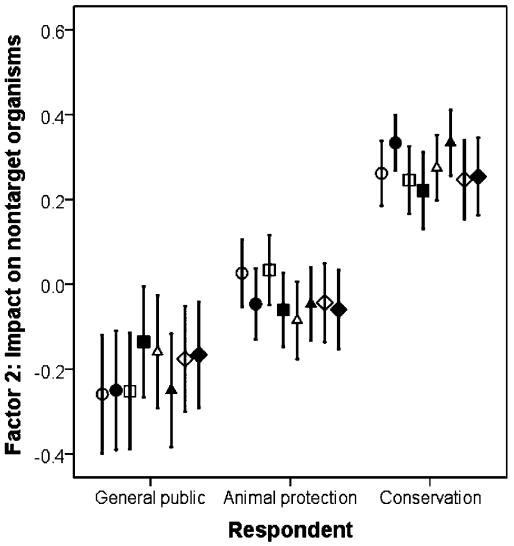

FIGURE 3 Scores from principal component analysis on Factor 2 (impact on nontarget organisms) as a consideration in determining primary method of control for all eight animal groups for each of the respondent groups. Error bars are mean ± 1 *SE* (○: rat, ●: possum, □: stoat, ■: rabbit, △: cat, ▲: deer, ◇: dog, and ♦: horse). Conservation is significantly different from animal protectionist ($p = .001$) and general public ($p = .052$), neither of which are significantly different from one another ($p = .372$).

TABLE 4
Effect of Animal Species on Degree to Which Three Factors Are Considered Important During Population Control

Animal	*Impact on Target Animals*	*Impact on Nontarget Organisms*	*Public Acceptance*
Rat	78 (40–94)	92 (81–96)	45 (11–74)
Possum	75 (54–92)	90 (82–96)	50 (24–73)
Stoat	82 (44–94)	91 (81–96)	47 (16–72)
Rabbit	85 (61–96)	91 (79–97)	53 (22–79)
Cat	88 (67–96)	90 (79–96)	56 (30–85)
Deer	87 (63–96)	89 (77–96)	53 (25–80)
Dog	91 (66–97)	91 (79–96)	61 (25–90)
Horse	91 (74–97)	90 (78–96)	57 (34–88)

Note. Median scores for factors considered important by all respondent groups combined (general public: $n = 91$, animal protectionists: $n = 91$, conservationists: $n = 81$) when selecting pest control methods for each animal group are shown. Scores are related to the three aspects of interest following principal component analysis (PCA), including impact on target animals (identified by PCA analysis: Factor 1), impact on nontarget organisms (identified by PCA analysis: Factor 2), and public acceptance of control method. Interquartile ranges are given in parentheses.

DISCUSSION

Our data show that conservationists scored the suite of eight animal groups more severely as pests than the general public and protectionists. There was broad agreement among respondent groups as to which were the most severe pests. Rats, possums, and stoats were identified as the most severe pests across all three respondent groups. Lethal control was the preferred method of control for all animal groups for conservationists. The general public held a similar view except for cats and dogs. Protectionists accepted lethal methods of control as the most preferred option only for rats, stoats, and deer. In general the importance of impacts on animal welfare in selecting a possible control measure declined the more severe the pest score of a particular animal group became. This occurred across all respondent groups although the relationship was weakest for the protectionists.

Women frequently differ from men in their attitudes toward animals; for example, they show increased empathy and have a less utilitarian view (Miller & Jones, 2006; Sanborn & Schmidt, 1995). Accordingly, differences in views among our respondent groups may at least partly reflect the female bias in the protectionist and conservationist respondent groups. Groups with a higher proportion of females may be more likely to prefer pest control measures perceived to cause less suffering. Notwithstanding, the female bias reported here is likely to be consistent with the group population and therefore represent the view of this respondent population. Evidence from elsewhere suggests that animal welfare or protection volunteer groups are heavily dominated by females (e.g., Neumann, 2010). Groupings of conservationists or wildlife managers may similarly have a female bias, although it is somewhat less marked than the previous group (Bonneau, Darville, Legg, Haggert, & Wilkins, 2009; Miller & Jones, 2006).

The generally higher pest score for all animals reported by the conservation group (Table 1) may reflect a more intimate knowledge of, and concern for, the impacts of introduced mammals on New Zealand's ecosystems. The pest scores provided by conservationists varied less than either of the other two groups, suggesting greater consensus within this group.

It is not surprising that concern for the welfare of pest animals as a factor influencing choice of the control method was highest in the protectionist group. The similarity in the level of concern expressed by the general public and conservationists may result from a shared view that the impact of the pest groups supersedes, to a degree, welfare concerns for them. However, the generally lower concern of the general public for the impact of control measures on nontarget animals compared with conservationists suggests that the largely urban general public may be less concerned with wild animals as a whole.

For all three respondent groups, the four animals with the highest pest ratings are the same (rats, stoats, possums, and rabbits). There is a wealth of evidence that rats, possums, and stoats are particularly damaging to New Zealand's natural ecosystems compared with the other pest groups (Innes, Kelly, Overton, & Gillies, 2010).

Rabbits and possums are significant pests in agricultural systems primarily because they compete with domesticated livestock for pasture (e.g., rabbits; Norbury & Norbury, 1996), act as vectors for disease in cattle, or damage cash crops (e.g., brushtail possums; Ryan et al., 2006). Our results indicate this evidence is effectively disseminated to the broader New Zealand society whether or not they have a specific interest in conservation or agricultural issues. The lower absolute pest scores for the other animal groups, particularly among the general public and protectionist group, are likely to reflect a number of other factors. These include their

broader societal role as companion animals (Hazel, Signal, & Taylor, 2011)—and in the case of deer, their use as a hunting resource utilized by a substantial lobby group (Nugent & Choquenot, 2004; Nugent & Fraser, 1993)—and greater levels of public concern over or value placed on larger or charismatic mammals (Fraser, 2001; Messmer, Brunson, Reiter, & Hewitt, 1999; Nimmo, Miller, & Adams, 2007). Complicated interactions between what constitutes pest, companion, and production animals likely exist for our respondent groups and influence the pest score provided; these should be further explored.

There was only a weak relationship between the degree to which an animal was considered a pest and the degree to which this affected concern for the animal's welfare and the choice of possible control measures for animal protectionists. This presumably reflects a view among this group that welfare concerns are paramount irrespective of the type of animal. An increasing body of literature evaluating the interaction between conservation imperatives and animal welfare goals suggests that there is recognition among professional wildlife managers and conservationists of the importance of considering the welfare impacts of pest management (e.g., Fitzgerald, 2009; Littin, 2010). However, issues around effectiveness and cost-effectiveness of particular control measures are also likely to play roles with this group (Barr, Lurz, Shirley, & Rushton, 2002; Fitzgerald, 2009). The strong negative correlation between pest score and welfare concern as seen within the general public group suggests that the perceived degree of impact of introduced vertebrates on New Zealand ecological and agricultural systems may override welfare concerns.

The substantially higher effect of the impact on target animals as a factor determining the primary method of control (see Figure 2) for the protectionist group compared with the conservationist and general public is consistent with the worldview of this group, which is probably reinforced by the significant gender skew toward females. Women are more likely than men to put greater value on compassion and protection of individual animals (Miller & Jones, 2006). The low score on this factor for the general public and conservationists is likely driven by recognition that lethal poisoning, although likely to have substantial costs for animal welfare compared with some other approaches, remains the only cost-effective solution for landscape scale pest control of three major pests (rats, stoats, and possums; Parliamentary Commissioner for the Environment, 2011). Negative experiences and perceptions of animals among the general public may also increase the likelihood that lethal control will be supported (e.g., feral cats; Lloyd & Miller, 2010) among this group.

The preferred method identified by groups for each animal was not necessarily representative of current control practices (e.g., protectionists selected contraception for rabbits; Table 2). Protectionists routinely preferred nonlethal control methods, whereas conservationists unequivocally selected lethal methods. Although it has been argued that instantaneous death does not constitute a welfare issue (Broom, 1998), many lethal control methods are not instantaneous. In particular poisoning, which although effective has the potential to cause substantial suffering from some toxins (e.g., Eason et al., 2010), is never selected by protectionists despite its widespread usage in pest control operations, particularly in New Zealand. There has been significant focus on the improvement of toxins to reduce welfare compromise in recent years (Littin, 2010). Dissemination of this information may reduce welfare-based opposition to poisoning.

The general public was also more likely to prefer lethal control methods, and it could therefore be suggested that the public is less opposed to the killing of nonnative species in

general. The general public only preferred nonlethal methods for feral cats and feral dogs with trap-neuter-release being the most preferred option. This is consistent with animal protectionists. The status of dogs and cats as common companion animals probably impacts the attitudes toward the acceptability of lethal control. Lethal control of these species may not receive public support if it is not appropriately justified and implemented. The preference for nonlethal methods of control also indicates that there may be little difference between the general public's concerns for the two species despite only one of the two being officially classified as a pest (i.e., the feral cat).

There was a strong acceptance for the lethal control of nonnative species by the general public and conservation groups including poisoning. The identification of poisoning as the most appropriate form of control of some species of pest animals by the general public identified in this study is in contrast to studies elsewhere (Barr et al., 2002) in which concerns about welfare implications, poisoning of nontarget animals, and potential risks to human health outweigh its acknowledged effectiveness (Barr et al., 2002; Fitzgerald, 2009).

Despite mostly nonlethal control methods being selected by the animal protection group, there were two exceptions. For both rats and stoats (ranked first and second, respectively) lethal control methods (but not poisoning) were indicated as preferred. The selection of lethal trapping in both instances suggests that protectionists do not oppose lethal control in some instances. None of the groups for any animal group selected the introduction of disease as an appropriate pest control measure (see also Fitzgerald, Fitzgerald, & Wilkinson, 2005). Currently disease is not widely or routinely used for the control of pest animals in New Zealand, and this is likely to influence the selection of this method. Disease use has also been identified as having both safety and extensive regulatory requirements (Saunders, Cooke, McColl, Shine, & Peacock, 2010), which may influence it as a choice. The mode by which many diseases cause death (e.g., myxomatosis) may be considered inhumane (Henning, Heuer, & Davies, 2005), and this may also reduce the likelihood of selection, particularly by animal protectionists.

The importance of public opinion in dictating control measures for nonnative species was considered of only moderate importance by all three sample groups (see Table 4) and was the least important of all factors evaluated. Similarly, Reiter, Brunson, and Schmidt (1999) established that residents in five Wildlife Services regions in the United States considered public opinion the least important criterion in selection of control measures. Notwithstanding, Mason and Littin (2003) noted that public awareness of pest control measures has previously resulted in the demand for increasingly humane methods to be recognized. As public concern for the welfare of animals continues to grow (Eggleston et al., 2003; Jordan, 2005; Meerburg et al., 2008), it becomes increasingly important to develop and utilize control methods that take into account the public's considerations with regard to welfare and the humane treatment of all species, including pests (Coleman, 2003), while continuing to protect New Zealand's ecosystems.

CONCLUSION

There is already some understanding within New Zealand as to how the general public views the development of new control techniques and the importance of concern for public health and animal welfare (Fisher, 2010). In addition to general concerns, understanding in more detail

a range of opinions and how they converge and diverge is important when the objective (the control of nonnative species) may be contentious. This should be further explored as part of pest control programs in order to improve effectiveness with support from all sectors of the animal industries. Also, by gaining a full understanding and representing the median opinion, extreme points of view are acknowledged (e.g., "no animal should be killed" or "cats and dogs should be banned in New Zealand") but placed in the context of a full range of views. Policy Delphi Analysis is one such method of focusing discussions to ensure that outcomes address concerns of all parties while allowing identification of areas of agreement. It has been used previously to address welfare issues for horses in Ireland using a focus group of individuals who are traditionally opposed to or reluctant to engage with one another (Collins, Hanlon, More, Wall, & Duggan, 2009; Collins et al., 2010). Further research on the topic of attitudes toward the control of nonnative animals should look to this methodology and consider areas that we suggest may provide consensus. This may include, for example, how best to control rats, stoats, and possums as major pests; how to protect the welfare of nontarget species; and how to improve acceptance of lethal control methods or the promotion of nonlethal control measures for cats. Future research should also integrate more opinions, possibly drawing from other groups with vested (but potentially contrasting) interests in this area (e.g., farmers, hunters, and animal rights advocates).

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APPENDIX

Please consider the following animal: Possums.

- To what extent do you consider this animal a pest? (Mark line)

_____

- Which method of control would you deem most appropriate for this animal? (Please circle). (a) Shooting, (b) Poisoning, (c) Trapping (lethal), (d) Introduction of disease, (e) Trap/neuter/release, (f) Contraception.
- How humane do you consider the following methods of control? (Please mark on the scale ranging from *least human* to *most humane*).

Shooting _____

Poisoning _____

Trapping (lethal) _____

Introduction of disease _____

Trap/neuter/release _____

Contraception _____

- How important are the following elements in determining the method of control?

Intensity of suffering of target animal _____

Duration of suffering _____

Impact upon nontarget species _____

Welfare of the target animal _____

Preservation of native flora and fauna _____

Welfare of nontarget species _____

Public acceptance _____