

RESEARCH ARTICLE

A comparison of attitudes towards introduced wildlife in New Zealand in 1994 and 2012

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Attitudes play an important role in introduced wildlife management. The attitudes of New Zealanders to introduced wildlife and their control were surveyed in 2012, and compared with attitudes in 1994. Attitudes to widely established introduced herbivores such as deer, possums and rabbits have remained consistent, whereas those for goats, pigs and uncommon species such as thar, chamois and wallabies are changing. New Zealanders generally accept that large mammals are both a resource and a pest requiring management and control. Attitudes to small herbivores such as possums and rabbits, and predators such as mustelids and rodents, are negative and focused on control or extermination using multiple methods. Less than 1% of respondents felt doing nothing was acceptable, but acceptability of poisons has declined. Future management of introduced animals in New Zealand will need to be situational and utilise mixed management methods appropriate to different demographics and stakeholders, while appropriately resolving conflict.

Keywords: 1080; control; deer; eradicate; herbivores; hunting; poison; possum; predators

Introduction

Humans arriving in New Zealand introduced new, non-native, species. Many of these introductions were intentional, bringing species that the incoming culture considered important for agriculture or recreation, although there have been unintentional introductions of hitch-hiking commensal species (e.g. rodents). There are now more than 90 introduced vertebrates established in New Zealand (Clout 2002). Some of these introduced species have significant negative impacts—agricultural, ecological and social (Clout 2002; Fitzgerald & Wilkinson 2009)—and the cost of pests in New Zealand has been estimated at NZ\$840 million annually, or 1% of GDP (Bertram 1999). Management of introduced species is necessary to moderate

both their beneficial use and their negative impacts. For some species, the duality of being both a resource and a pest can cause conflict among people with different attitudes towards the species and their management. Common examples in New Zealand include the management of game animals such as deer which are valued both commercially and recreationally but also have negative impacts on native forest (Nugent & Fraser 1993), and the management of possums (*Trichosurus vulpecula*) which have negative impacts on forests and agriculture, but are also valued for their fur (Jones et al. 2012). Attitudes to control methods for management can also be controversial, such as the widespread use of poison, especially its aerial application (PCE 2011).

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Supplementary file 1: 2012 survey; **Supplementary file 2:** Summary data notes; **Supplementary file 3:** 1994 and 2012 summary data.

Attitudes of people, both from organised interest groups or different public demographics, play an important role in the management of introduced wildlife (Bremner & Park 2007), indeed most conservation conflict in wildlife management is essentially a human-human issue (Redpath et al. 2013). The study of attitudes to wildlife is generally considered within the discipline of Human Dimensions of Wildlife Management (Decker et al. 2004), whereas attitudes to pest control techniques draw upon work from Science, Technology and Society studies and Risk Perception studies (Fitzgerald 2009). Perception, risk and uncertainty all play major roles in introduced species management decision-making frameworks (Liu et al. 2011). Ajzen and Fishbein's (1980) Theory of Reasoned Action provides an effective framework for considering the role of attitudes, whereby an individual's actual behaviour can be reasonably predicted from their attitudes and prevailing subjective norms.

New Zealand is a young nation and has 'imported' many of its attitudes to wildlife management from other countries. These attitudes have changed following colonisation and subsequently evolved with national identity. Without understanding the prevalence and diversity of different attitudes towards introduced wildlife and their control, and how these shift over time, it is difficult to enact broadly acceptable management decisions with minimal conflict. In the worst case, implementing a management decision without considering widespread attitudes, even if it might be considered the most appropriate course of action by managers, may generate social conflict that ultimately is not productive for successful long-term management (Fitzgerald 2009). Furthermore, polarised environmental attitudes can be presented in the media, distorting perceptions of the actual prevalence of some views (Veitch & Clout 2001). Although all attitudes are subjective to some extent, some attitudes held may not reasonably consider available scientific evidence to the contrary (Fraser 2001). Thus, understanding environmental attitudes is important as, more so than ever, the public is expected and expects to be included in conservation decision-making and management (Lawrence et al. 1997).

Much effort over the past 20 years in New Zealand has focused on developing and refining technologies for introduced animal management (Clout & Williams 2009) and understanding the biology of target species (Allen & Lee 2006). However, relatively less work has focused on the attitudes of New Zealanders to different introduced species and their management. Historically, possums, rabbits (*Oryctolagus cuniculus*) and stoats (*Mustela erminea*) have received much attention (Fraser 2006). Fraser (2006) found that specificity, humaneness and degrees of uncertainty are the major elements of control method acceptability. Established ('traditional') control methods such as hunting, trapping and poisoning have tended to receive the lowest preference rating (Fisher et al. 2012). Fitzgerald et al. (2007) reviewed attitudes in Australia and New Zealand to introduced wildlife and their impacts, and Fitzgerald (2009) reviewed and summarised attitudes in Australia and New Zealand to introduced wildlife impacts on the environment, and comparatively among control methods. Both studies found attitudes to introduced wildlife differed between traditional 'market segments' of demographics within the 'public' (e.g. gender, age, residence and income), but also had strong situational elements such as the target species and their perceived impact (Fitzgerald et al. 2007). This situational context of proposed management likely plays an important role in attitudes to introduced wildlife management methods. Interest groups also play an important role, and although some interest groups do not agree on the problems, others can agree on the problem but disagree on the solution (Fitzgerald et al. 2007). There is also an important role of sociocultural context, including cultural roots and changing cultural norms (Fitzgerald et al. 2007). 'New social movements' associated with rights in post-industrial Western society can particularly play an important role in shaping attitudes. New Zealand's situation as an insular nation strongly impacted by introduced wildlife is an additional sociocultural consideration, where factors such as the absence of most terrestrial mammals distinguish it from continental environments.

Table 1 Common names, scientific names and 2012 legal status of native and introduced species in the Fraser 1994 survey and this study.

Common name	Species	Legal status
Brush-tail possum	<i>Trichosurus vulpecula</i>	Introduced, pest
Chamois	<i>Rupicapra rupicapra</i>	Introduced, pest
Fallow deer	<i>Dama dama</i>	Introduced, pest
Red deer	<i>Cervus elaphus scoticus</i>	Introduced, pest
Rusa deer	<i>Cervus timorensis</i>	Introduced, pest
Samba deer	<i>Cervus unicolor</i>	Introduced, pest
Sika deer	<i>Cervus nippon</i>	Introduced, pest
Wapiti	<i>Cervus elaphus nelsoni</i>	Introduced, pest
White-tailed deer	<i>Odocoileus virginianus</i>	Introduced, pest
Feral cat	<i>Felis catus</i>	Introduced, pest
Feral goat	<i>Capra hircus</i>	Introduced, pest
Feral horse	<i>Equus caballus</i>	Introduced, pest
Feral pig	<i>Sus scrofa</i>	Introduced, pest
Ferret	<i>Mustela furo</i>	Introduced, pest
Hare	<i>Lepus europaeus</i>	Introduced, pest
Himalayan thar	<i>Hemitragus jemlahicus</i>	Introduced, pest
Rabbit	<i>Oryctolagus cuniculus</i>	Introduced, pest
Stoat	<i>Mustela erminea</i>	Introduced, pest
Bennett's wallaby	<i>Macropus rufogriseus rufogriseus</i>	Introduced, pest
Brush-tailed rock wallaby	<i>Petrogale penicillata penicillata</i>	Introduced, pest
Dama wallaby	<i>Macropus eugenii</i>	Introduced, pest
Parma wallaby	<i>Macropus parma</i>	Introduced, pest
Swamp wallaby	<i>Wallabia bicolor</i>	Introduced, pest
Wasp	four species	Introduced, pest
Weasel	<i>Mustela nivalis vulgaris</i>	Introduced, pest
Long-tailed bat	<i>Chalinolobus tuberculatus</i>	Native, protected
Lesser short-tailed bat	<i>Mystacina tuberculata</i>	Native, protected
Kiwi	five species	Native, protected
Takahe	<i>Porphyrio hochstetteri</i>	Native, protected
Weta	>70 species	Native, some protected

In 1994, a national survey was undertaken on attitudes to introduced wildlife in New Zealand. Table 1 lists species referred to in the survey. This survey considered the general knowledge and experience of people with regard to introduced wildlife and the outdoors in general, their attitudes to introduced species and their attitudes to animal management. The findings of this survey were published as a report in 2001 (Fraser 2001). Overall it was suggested that New Zealanders have more of a utilitarian (balancing the greater good) than protectionist (preservation for their own sake) attitude to introduced wildlife, but with important

elements of sensitisation to global trends in biodiversity and conservation management, environmental pollution and animal welfare, stemming from various 'new social movements' (Fitzgerald et al. 2007). I repeated this survey in 2012 to assess the current status of attitudes to introduced wildlife in New Zealand and how these may have changed (or not) over nearly 20 years.

Methods

I used the facsimile of the 1994 survey by Wayne Fraser (Appendix in Fraser 2001, hereafter 'Fraser

1994') as the basis for an updated survey in 2012 (supplementary file 1). This survey was repeated verbatim except for a small number of minor changes; correction to 2012 values for inflation (prize draw, Q10 deer farming industry, Q19 bovine Tb impact, Q29 income brackets doubled) and the addition of mustelids and rodents as additional pests (Q12 predator control, Q15 target species, Q21 target species) and replacing an outdated question to reflect changing values (Q17 on Kaimanawa horses in 1994 was changed to control versus eradication in 2012). This new question sought respondents' views on the management of introduced animals on the 'mainland' (the two main islands of New Zealand; North and South), where it is now possible (unlike in 1994) to permanently eradicate introduced mammals from some areas, at a greater but one-off cost, compared with ongoing low-cost control. These changes were necessary to reflect subtle changes in approaches and attitudes to pest control over the past 20 years in New Zealand, but were not expected to materially alter the overall results and longitudinal comparison.

The survey was posted out in early March 2012, the same month used by Fraser in 1994, and also with a prize draw. Three thousand recipients were randomly chosen from the 2011 New Zealand national electoral role of nearly 3 million adults over 18 years old ($n = 2,956,271$) using a python script. This sampling strategy was almost identical to that used by Fraser in 1994 who used 2,828 people, although from a smaller electoral pool and for adults over 20 years old.

All analyses of results within 2012, between 2012 and the national 2013 census, and between 1994 and 2012 were done by chi-square analysis of count data, with an alpha value of 0.05 used for significance whenever a difference is stated. Where relevant for 2012 data, cross-tabulations of responses by gender, residence (urban/rural), island (North/South) and income are also given, and log-linear models used to estimate higher-order interactions among three or more factors. Comparisons of survey respondent demography with 1994 and 2013 census data were also included. The original data from the Fraser 1994

survey were not available; however, summary statistics by question were published in the original report and could be used comparatively. This constrained the comparisons that could be made (in particular cross-tabulation interactions between questions could not be compared); however, ample data were still available for making meaningful longitudinal comparisons. Summary statistics from Fraser 1994 were provided as combinations of count data and percentages. Where percentages were provided without count data, they were back-calculated to the number of survey respondents for comparison with 2012 results, as chi-square analyses must be done on count data and not percentages, since the latter creates inappropriate dependencies in the data (rows or columns sum to 100% by design). For some questions in the original Fraser 1994 survey it was not possible to calculate the original number of respondents as only ranges were presented (Q5, Q6, Q8, Q15, Q16 and Q18). For these questions I interpolated the 1994 sample size using linear regression of the full 2012 number of respondents for that question. For all except Q5, the ranges of the Fraser 1994 survey were small (<12% difference between minimum to maximum) and so this imputation method was considered sufficient, and the final significance test unlikely to be affected except for values close to alpha (0.05).

Results

Responses and demographics

Eight hundred and one surveys were returned completed. One hundred and thirteen surveys were returned to sender (3.8%). The overall effective response rate was 27.7%, slightly lower than the rate of 33% in 1994, but a similar number of respondents ($n = 859$) given my larger mailing list. Respondents were divided evenly between genders, differing from neither the Fraser 1994 survey nor national census data for 2013. Seventy-two per cent of respondents were urban residents (c.f. rural) and 72% from the North (c.f. South) Island, typical of the New Zealand population. Income did not

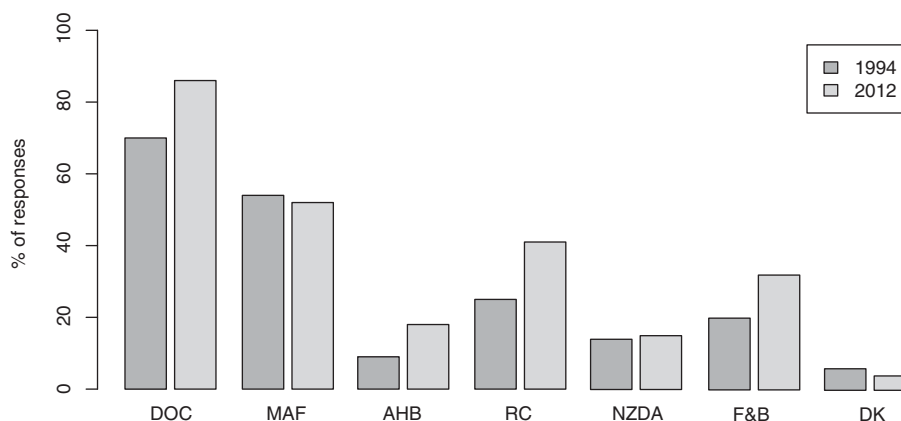


Figure 1 Change from 1994 to 2012 in perceptions of agency responsibility for introduced pest control. DOC, New Zealand Department of Conservation; MAF, Ministry of Agriculture and Fisheries (now MPI [Ministry for Primary Industries]); AHB, Animal Health Board; RC, regional councils; NZDA, New Zealand Deerstalkers Association; F&B, Royal Forest and Bird Protection Society of New Zealand; DK, don't know.

depend on residence. There was no significant difference between 1994 and 2012 in the number of respondents by gender ($P = 0.142$), residence ($P = 0.434$) and island ($P = 0.687$). Most respondents identified with European ethnicity (89%) and the remainder were Māori (4.5%), New Zealander (European and Māori 1.5%), Polynesian (1.0%), Asian (2.1%) or other (1.9%). Although this result did not differ from 1994, the number of respondents by ethnicity in 2012 significantly differed from 2013 national census data ($P < 0.001$). Europeans were over-represented while Māori, Polynesians and Asians were all significantly under-represented, probably reflecting a bias in self-selection, although possibly also national electoral roll registration. The number of respondents by age category in 2012 significantly differed from 1994 ($P < 0.001$) and 2013 national census data ($P < 0.001$). Compared with national population estimates for 2013, there were 33% fewer under 30 year olds, particularly males, who responded in 2012 while there were 21% more over 60 year olds, particularly males, who responded. Compared with 1994, there were also fewer respondents in the 21–40 age categories and more respondents in the over 60 category. This trend within 2012 and compared with 1994 probably represents changes in

self-selection behaviour for surveys. However, due to a typesetting error, age categories were not presented ordinally which may make these data unreliable. Interestingly, although there was no significant difference in age class responses by gender in 2012, there was in 1994, with females over-represented in the 31–40 age class but under-represented in the 60+ age class. Overall the 2012 responses were significantly positively biased in both age (older) and ethnicity (European), but are otherwise a representative sample of the population of New Zealand in 2012.

General knowledge and experience

There are now 30 introduced mammals in New Zealand (two wallaby species have been eradicated since 1994), although 66% of respondents answered that there were fewer than 30. This is a similar result to 1994, but unsurprising given that many of the species are patchily distributed (e.g. wallabies, thar and chamois) or part of colloquial species complexes (e.g. three species of rats and seven species of deer). Perceptions of agency responsibility for introduced animal control had changed significantly since 1994 ($P < 0.001$), with respondents overall identifying more agencies as responsible (Fig. 1).

Respondents reported on their interactions with nature and experiences with introduced mammals in nature. Three-quarters of respondents had visited a national park or large forest area in the past 5 years, which was consistent with results from 1994 ($P = 0.438$). Although this result did not depend on which island a participant lived ($P = 0.064$), having visited a national park or large forest area was 24% less likely for urban respondents ($P = 0.016$) and 20% more likely for those respondents earning >NZ\$80,000 ($P < 0.001$). The types of introduced animals seen during those visits by the 58% who responded were broadly similar to 1994, but included more sightings of wasps ($P < 0.001$), goats ($P = 0.007$) and pigs ($P = 0.010$) and about the same number of sightings of possums ($P = 0.216$), deer ($P = 0.151$), chamois/thar ($P = 0.227$). As in 1994, sightings of possums may have included dead possums (a common sight on roads) and of farmed goats and deer (also a more common sight than in the wild). In general, sightings of large wild mammals were considered to add to the outdoor experience (in descending order: deer, chamois, pigs and goats), although since 1994, 12% fewer people now considered goats as detracting from the experience, and 14% fewer people now considered pigs as adding to the experience. Fifteen per cent fewer people also now considered chamois as adding to the experience, but this was only from a small number of sightings and was not significant. Sightings of possums and wasps were generally considered as detracting from the experience, although since 1994 12% fewer people now considered wasps as detracting from the experience.

Attitudes to introduced species

For responses hereafter, changes since 1994 include movement from the 'don't know' category to either positive or negative associations (i.e. formation of attitudes), or changes in both the positive and negative associations due to shifts between them (i.e. change in attitudes).

Respondents classified species as a resource, pest or both. Hunted large mammals (deer, chamois and thar) were equally considered either a resource,

or both a pest and a resource, and less often pests. Horses, pigs and goats were mostly considered a pest and a resource. All other introduced animals were mostly considered pests (in descending order: rodents, cats, mustelids, wasps, possums, rabbits, hares, wallabies). Results in 2012 were generally consistent with 1994, although more respondents now considered chamois ($P < 0.001$), thar ($P < 0.001$), horses ($P < 0.001$), wallabies ($P = 0.014$), mustelids ($P < 0.001$) and cats ($P < 0.001$) as pests, while fewer people considered pigs ($P < 0.001$) and wasps ($P = 0.007$) as pests. Changes in attitudes (a shift from resource to pest) occurred for chamois and thar, and more respondents classified mustelids as pests in 2012.

Respondents imagining they saw a particular species in the outdoors generally considered large mammals would add to their enjoyment (in descending order of enjoyment: deer, horses, chamois, thar, goats, wallabies and pigs), while smaller animals would not be enjoyed (in descending order of lack of enjoyment: rodents, wasps, cats, mustelids, possums, rabbits, hares). This result was similar to those respondents who had actually seen these species in the outdoors earlier in the survey. Many of these perceptions of enjoyment had changed since 1994. Significant shifts in attitudes from 'enjoyment' to 'would not enjoy' occurred for (in descending order of magnitude, all $P < 0.05$): chamois, mustelids, thar, horses and cats; but to increased 'enjoyment' for (in descending order of magnitude, all $P < 0.05$): pigs and goats.

Almost half of the respondents (46%) felt introduced animals were a problem to them directly, but this differed significantly by residence (72% of rural respondents versus 37% of urban respondents, $P < 0.001$). Comparative data from 1994 were not available. One-third of the respondents (32%) believed that the modification of our native forests and grasslands by large wild animals was an acceptable price to pay for the recreational opportunities they allowed. Male respondents (38%) were more likely than female respondents (26%) to believe this ($P = 0.01$). This result was consistent with 1994 ($P = 0.719$; genders combined). About half of the 2012 respondents (49%) felt that modification of our native forests caused

by deer has been an acceptable price to pay for the present deer farming industry. Once again, male respondents (55%) were more likely than female respondents (43%) to believe this ($P = 0.013$). Neither result depended on the respondent's residence ($P = 0.978$) or island ($P = 0.496$). However, for deer farming the belief that any modification was acceptable had increased from 42% in 1994 to 49% in 2012 ($P < 0.001$; genders combined). In particular, this was from a 19% decrease in respondents saying no, coupled with a doubling in those who did not know from 13% in 1994 to 26% in 2012.

More than twice as many respondents (50%) believed not enough was being done to manage or control introduced animals to limit or reduce their impacts on the environment, as believed enough was being done (23%), with more females (33%) than males (22%) responding they did not know. This result did not depend on the respondent's residence ($P = 0.056$), island ($P = 0.395$) or income ($P = 0.940$). However, if respondents had not visited a national park or large forested area in the past 5 years, they were 18% less likely to believe not enough was being done, or 30% more likely not to know ($P = 0.004$). They were also 23% more likely to think not enough was being done if introduced animals caused them a problem directly, and equivalently 20% less likely if they didn't ($P < 0.001$). The belief that not enough was being done had also declined overall from 65% in 1994 to 50% in 2012 ($P < 0.001$; genders combined).

Respondents were asked to apportion NZ\$100 of tax among eight categories of pest control of wild animals (Fig. 2). Twelve and a half percent of respondents ticked groups instead of assigning dollar values, and these were interpreted as an equal apportioning among the selected groups. In 2012, this question also included the category 'predators (rats and mustelids)' which in 1994 would have been incorporated within 'other'. In 2012, the open-ended 'other' category responses included (in descending order): cats, pigs, fish, horses, wallabies, dogs, birds, ants, plants and mosquitos. All non-mammalian groups were new compared with 1994, suggesting a diversification of perceptions of what constitutes a pest species in 2012. Spending on possum, rabbit and wasp

control was similar to 1994, but increased spending in 2012 on small predators (rats and mustelids) was at the cost of spending on deer, thar and goat (all halved) and 'other' (now very little with the new predator category).

Sixty two per cent of respondents believed that introduced animals could still not be considered part of our natural fauna after 100 years, while 27% felt they could, regardless of gender ($P = 0.309$). This was a significant change in attitude of about 5% from 1994 when more respondents believed they could be considered part of our natural fauna ($P = 0.009$), although with greater numbers not knowing in 2012. When hypothetically asked how long a species had to be in New Zealand before it could be considered 'natural' fauna, 46% of respondents said 'never', consistent with 1994 ($P = 0.710$). For those that gave a number of years, values varied from 2 years to more than 10,000 years, with a mean of 295 years, which was higher than the mean in 1994 of 200 years, although this difference is probably due to the inclusion of a few more very large numbers in 2012. Twenty six per cent of respondents answered 'don't know' for this question.

Respondents classified whether each species should be managed as a resource, controlled, exterminated or have nothing done. Most respondents believed large mammals should be managed as a resource (in descending order: deer, pig, chamois, goat, thar), followed by controlled (in descending order: goat, pig, thar, chamois, deer) and less than 10% of respondents believed they should be exterminated. Most respondents thought wallabies should be controlled, and the remaining introduced small mammals exterminated (in descending order: rodents, mustelids, possums, rabbits). For all species, less than 5% of respondents thought nothing should be done; however, more than 10% did not know for uncommon species (wallabies, chamois and thar). These results were generally consistent with those in 1994 except fewer respondents thought goats ($P < 0.001$) and pigs ($P = 0.006$) should be exterminated, and more thought they should be managed as a resource rather than controlled. More respondents ($P < 0.001$) thought rabbits should be controlled, rather

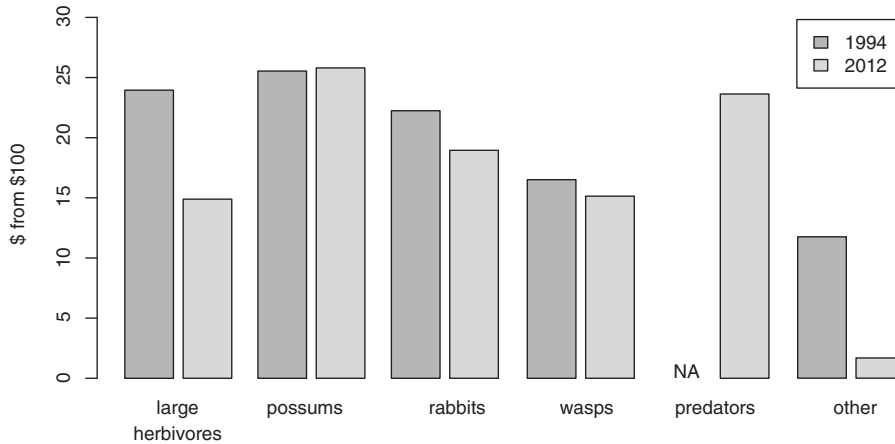


Figure 2 Change from 1994 to 2012 in how people would prefer to see a nominal NZ\$100 tax spent on wild animal control. ‘Large herbivores’ comprise deer, thar and goat. ‘Predators’ comprise rats and mustelids.

than exterminated or managed as a resource. Rodents and mustelids were not surveyed in 1994 so it was not possible to make a comparison over time.

Respondents were asked to rate seeing species in the wild on a scale of 1 (least pleasure) to 5 (most pleasure). Candidate species were all familiar and included introduced species (possums and deer) and native species, including charismatic birds (kiwi and takahe) and less charismatic animals (the large endemic ‘weta’ cricket and bats). Ninety two per cent of respondents considered seeing possums as least pleasurable (ranking 1 or 2), as they had in 1994 ($P = 0.458$). Only 23% of respondents considered seeing deer as least pleasurable (ranking 1 or 2), although this had increased from 17% in 1994. Forty eight per cent of respondents considered seeing a deer would be pleasurable (ranking 4 or 5), but this had also declined from 56% in 1994, overall suggesting a change in attitude to deer ($P = 0.005$). Respondents clearly anticipated deriving pleasure from seeing iconic native bird species such as kiwi (98%; $P = 0.412$) and takahe (89%; $P = 0.149$), to the same extent they did in 1994. Respondents now also expected to derive pleasure from seeing less charismatic native species such as bats (52%; $P = 0.001$) and weta (42%; $P < 0.001$), a significant change from 1994 when both species rated

considerably lower than deer (43% and 24%, respectively). Some respondents may have been confused by the ordinal scale used where 1 was in fact ‘least pleasure’ following the original Fraser 1994 survey.

Respondents were asked to select their preferred management intervention from ‘doing nothing’, ‘ongoing low-cost control’ or ‘one-off high-cost eradication’. Less than 1% of respondents felt doing nothing was an option. Twenty per cent of respondents felt eradication was the preferred choice of management where possible, while 66% felt ongoing low-cost control was the preferred option. Thirteen per cent did not know what the best method would be. This result did not depend on respondent gender ($P = 0.062$), residence ($P = 0.729$), island ($P = 0.196$) or income ($P = 0.161$).

Attitudes to animal management

Respondents were asked to prioritise introduced animal management by ranking four categories: predators (cats, mustelids and rodents), small herbivores (rabbits and possums), large herbivores (deer, etc) and wasps. In descending order of those ranked first were predators (56%), small herbivores (34%), wasps (17%) and large herbivores (8%) (note these do not add to 100% by design). Attitudes to introduced animal management prioritisation

have changed significantly since 1994 ($P < 0.001$), when small herbivores (60%) were prioritised over predators (24%), and wasps (21%) and large herbivores (11%) were a slightly higher priority.

Sixty six per cent of respondents, regardless of gender ($P = 0.848$), were concerned about possum impacts on both the agricultural industry and conservation values, the remainder comprising 23% more concerned about impacts on conservation, 9% more concerned about impacts on agriculture, and only 2% who were not sure, suggesting a high level of clarity when considering non-mutually exclusive values. Furthermore, concern for possum impacts did not depend on respondent's residence ($P = 0.515$) or income ($P = 0.562$), but respondents from the South Island were twice as likely to be concerned about agricultural rather than conservation impacts (14% South versus 8% North; $P = 0.011$). These attitudes had changed significantly since 1994 ($P = 0.003$) with 5% more respondents now more concerned about conservation values in deference to the agricultural industry, although there was no change in those who considered the threat to both. As in 1994 ($P = 0.536$), 95% of respondents felt commercial use of animal carcasses (conditional on control objectives being achieved) was preferred to leaving them where they fall, although this question did not elaborate on the increased economic costs of undertaking such a course of action.

For large mammals, shooting was the preferred method of control for deer (99%), goats (90%) and pigs (74%) with hunting dogs also used for pigs (22%) and goats (7%). Less than 2% of respondents chose poison as the most acceptable control method for targeting these species. For small mammals, a variety of methods were all preferred (Fig. 3). Attitudes to pig ($P = 0.161$) and deer ($P = 0.062$) control had not changed since 1994, but use of poisons for controlling goats (-4%; $P = 0.005$), rabbits (-10%; $P < 0.001$) and possums (-14%; $P < 0.001$) had all lost favour in preference to shooting (goats) and trapping (rabbits and possums). Rodents and mustelids were not surveyed in 1994 so it was not possible to make a comparison over time. For cats, shooting (-9%) and poisoning (-15%) had both lost favour in preference to trapping (+8%;

$P < 0.001$). Preference for use of biocontrols among all tools remained low (<17% for applicable species) and has not changed since 1994. Although selecting multiple control methods was not permitted, some respondents did this nonetheless. Eighty four per cent of respondents believed control methods should meet some minimum method of humaneness, down from 88% in 1994 ($P = 0.044$), and differing significantly by gender (79% males versus 89% females; $P < 0.001$). This attitude did not depend on residence ($P = 0.797$), island ($P = 0.963$) or income ($P = 0.085$). When considered alone, 58% of respondents favoured pest-specific biocontrol agents while 28% did not, a small but significant change in attitude of 4% more in favour since 1994 ($P = 0.003$). This result also differed between genders (65% support by males versus 51% by females; $P < 0.001$). Females were once again also twice as unlikely to be undecided (9% males versus 18% females). This attitude did not depend on residence ($P = 0.788$), island ($P = 0.390$) or income ($P = 0.740$).

Forty two per cent of respondents believed poisons such as '1080' should be allowed to be used, whereas 40% believed they should not be allowed, the remaining 18% being undecided. This was a significant change in attitude of about 9% from support to opposition since 1994 ($P < 0.001$). This also differed significantly by gender (53% support and 35% opposition by males versus 32% support and 45% opposition by females; $P < 0.001$). Females were also twice as likely to be undecided (12% males versus 23% females). This also differed significantly by residence (37% urban versus 47% rural opposition; $P = 0.032$) and income ($P = 0.003$), with respondents earning >NZ\$80,000 deviating significantly from the norm with much greater support (58%) rather than opposition (22%) to poison use. Attitudes to poison use in 1994 also differed in a similar pattern by gender, with support more likely from males, and opposition more likely from females, but did not differ significantly by residence. The interaction of environment and income on poison support in 2012 was further investigated using a log-linear model, and the elevated support of poison use by those with high incomes was being

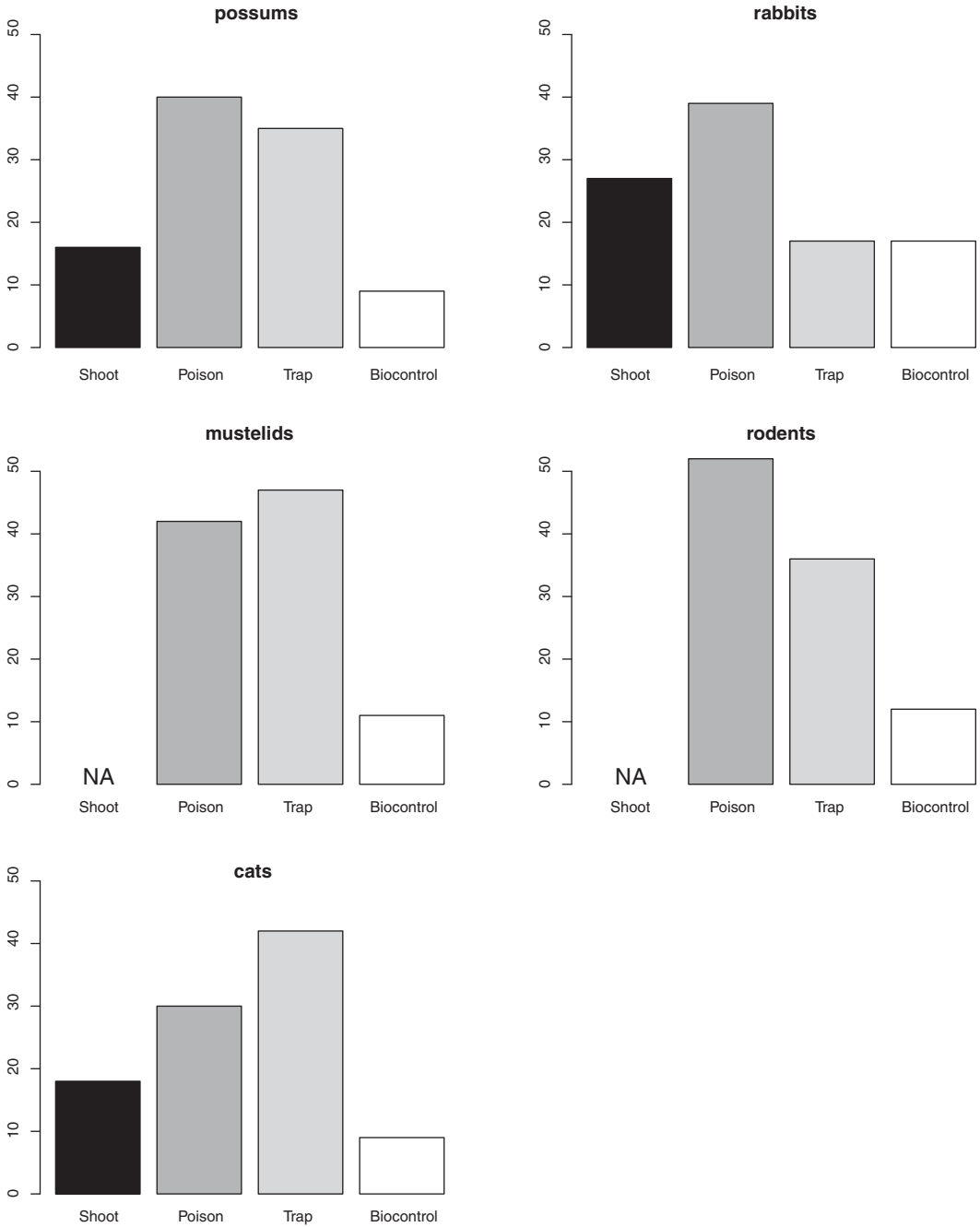


Figure 3 Percentage preference for small introduced mammal (possum, rabbit, mustelid, rodent and cat) control methods in the 2012 survey.

driven by rural respondents. Additionally, respondents were less likely to support poison use if they had visited a national park or forest area in the past 5 years (and equivalently more likely if they hadn't); however, whether introduced animals affected them directly did not affect their view on poison use. For those with established views on whether enough is being done to control introduced animals and whether poison use should be allowed (i.e. responded yes or no), support for poison use did not depend on whether respondents thought enough was being done to manage impacts. However, in 2012, more respondents did not know whether enough is being done than would have been expected, suggesting an elevated level of uncertainty.

Discussion

The response rates and demography of the 1994 and 2012 survey were similar which suggests that they can be robustly compared to give an indication of changes in attitudes to introduced mammals and their management over nearly 20 years. Outdoors experience reflected typical non-random patterns of use (Pearce & Booth 1987), such as greater access and motivation to visit national parks and forest areas by rural and high-income earners.

Perceptions of management responsibility for introduced mammals were similar, although in 2012 more responsibility is attached to almost all organisations for pest management, even when they do not have such responsibilities. Although the Department of Conservation (DOC) was identified as having the greatest responsibility for pest control, the Animal Health Board (AHB) was not often identified, even though it undertakes, for example, the most aerial 1080 poison operations (in 2011, treated land area was 57% by AHB c.f. 7% by DOC; EPA 2012). Similarly, regional councils that have local jurisdiction were not strongly identified by respondents, whereas lobbying organisations with no mandate for control were identified, such as the Royal Forest and Bird Protection Society of New Zealand and the New Zealand Deerstalkers Association. This might represent confusion between organisations lobbying for pest

management compared with those actually legislatively responsible. Perceived responsibility is also probably highly contingent on organisation visibility (e.g. media coverage) and mandate (e.g. public versus private lands) rather than actual pest management undertaken. Very few respondents believed any of these species should be managed under a 'do nothing' scenario.

Hunted large introduced mammals are now classified as game animals under the Game Animal Council Act (2013). They tend to be viewed as either a resource, or a resource with negative (pest) impacts, but generally are perceived as adding to the outdoors experience. Game animals are generally accepted in New Zealand as part of the environment, although not considered natural fauna. The impact of deer is largely considered acceptable and large mammals are lowest priority for pest management; in 2012, less funding was assigned to them as small predators also require management. Management of large mammals as a resource is the preferred approach, with control playing an important role and shooting the preferred control method. Little support exists for completely eradicating large mammals and poison is not considered acceptable for their control (nor is currently used in their control). Attitudes to deer have remained largely static over nearly 20 years, but attitudes to uncommon large mammals (e.g. thar, chamois and wallabies) have changed with more people considering them a pest and believing they should be controlled. Attitudes to deer in New Zealand differ from those in other countries where they are more often considered a pest (Fitzgerald 2009). Attitudes to pigs and goats in New Zealand are in a state of flux. Both species are still considered both a pest and resource, but although fewer people now consider pigs as a pest, they are not considered as adding to the outdoors experience. Generally, people still acknowledge goats and pigs as pests, but attitudes towards them are shifting towards those held for deer, with a view that controlling pigs by shooting and with dogs is appropriate.

Attitudes to small predators have changed significantly in 20 years. They are considered pests detracting from the outdoors experience, and

identified as the highest priority for management, with 25% of budgets assigned to this purpose. Most people believe they should be controlled if not exterminated, using a combination of trapping or poisoning, which is likely to depend on the region. Importantly, all reference to cats in this survey was to feral cats, and respondents clearly recognised this. The distinction between pest and pet cats is clear in New Zealand, and domestic cat management was outside the scope of this study. In contrast, attitudes to small herbivores (although possums are omnivorous) have remained the same. They are still considered pests and people consider they would detract from any outdoors experience. It was believed they should be exterminated or controlled and 45% of budgets were dedicated to this, even though they were no longer the highest priority for management. People are concerned about the impact of possums on both agriculture and conservation, suggesting management for either reason would be acceptable. The shift from 1994 to 2012 for control over extermination of rabbits might reflect a high-profile, illegal biological control introduction (rabbit haemorrhagic disease) between surveys in 1997 which significantly reduced rabbit densities (Cooke & Fenner 2002). As others have found, introduced predators and small herbivores now have the highest pest status in New Zealand (Farnworth et al. 2014).

The final introduced animal considered was wasps, which in the 1990s were topical as an emerging pest species (Beggs et al. 2011). Since then, wasps were nationally classified as pests, but although more people have encountered them, there is less concern and perception of them as pests, although the majority still classify them as such. Pest management spending should not exclude invertebrate pests such as wasps. The change in attitudes towards wasps might reflect desensitising attitudes post-invasion which have also been recorded in Australia for rabbits (Fisher et al. 2012).

Attitudes have also changed towards how native species are valued, as measured by pleasure, in comparison with introduced species. In 1994, less charismatic species such as bats and weta were

valued less than deer, but were rated higher in 2012. Charismatic native birds are still most valued, reflecting an ongoing bias in attitudes of New Zealanders to such animals (Seabrook-Davison *in press*). Overall, this change in attitude likely reflects a broadening appreciation of native fauna diversity in New Zealand, beyond those species that historically dominated conservation initiatives (Seddon et al. 2005).

Balancing the commercial and recreational benefits of introduced species with their negative ecological impacts can be difficult. Some people may take opposing attitudes on whether a species is a resource or pest and be unwilling to accept alternative attitudes, whereas others may be able to accept and reconcile both views, as part of an individual's 'wildlife acceptance capacity' (the maximum wildlife population level in an area that is acceptable to people *sensu* Carpenter et al. 2000). Generally, people accepted that some introduced animals had both resource and pest values, and should be managed as such. In particular, for game animals, respondents generally considered they were a resource, and derived enjoyment from seeing (or potentially seeing) them. It is difficult to determine if this attitude is because respondents do not acknowledge the negative ecological impact, or is despite it, but people are more inclined to accept trade-offs for economic gain such as farming, rather than for recreational gains such as hunting.

One topic that had a noticeable shift was attitude to poison use, exemplified as 1080 (often a synonym for the poison debate). There has been an ongoing public debate on the use of 1080 in New Zealand (Green & Rohan 2012) and, in general, preference for any poison use is low and continues to decline (Fraser 2006). This could lead to increased conservation conflict since government policy focuses on increasing 1080 use (PCE 2011). Given the highly visible and polarised public debate on 1080 it is perhaps surprising that the change in attitude towards poison use from 1994 to 2012 is not greater than 10%. Although opposition to poison use has increased, this issue is nuanced, and in fact the '1080 issue' itself may relate more to the method of toxin delivery, perceived as

'indiscriminate' when aerial, rather than the actual toxin itself, for which there is more support when delivered in ground-based operations (Kannemeyer 2013). At the same time, although alternative vertebrate biological control methods remain conceptual (Fitzgerald 2009), support for these methods has continued to increase. Although parasites or diseases were given in the survey as an application of biocontrol, the first development of species-specific methods will probably come from pest-specific toxins, while other methods might involve negatively perceived genetic engineering (Duckworth et al. 2006). Therefore this question might be considered misleading, as the type of biological control method matters (Fitzgerald 2009). As other studies have found, humaneness of control methods is a high concern, but the level of concern differed by gender; however, in contrast it did not depend on residence (Fitzgerald 2009). Other studies have recently found that as perception of pest status increases, the importance of humaneness declines, although this was for a predominantly urban population (Farnworth et al. 2014).

This study reported the attitudes of New Zealanders to techniques for introduced animal management, but did not consider the economic or humaneness components of those methods. Although the humaneness of starkly different techniques is somewhat implicit in the technique itself (although notwithstanding important variations from poor technique implementation), economic costs are an important consideration in different situations. However, economic costs are considered only by some stakeholders, and the public tend not to consider them (Fitzgerald 2009). Alternatively, the use of ground-based methods such as trapping and shooting may be favoured but can be limited by site accessibility. There are some locations where the only current control options are aerial poison campaigns or no action, and very few respondents believe no action is an appropriate management choice. A mixed-method situational approach to introduced animal management in New Zealand is probably most appropriate, where at any given site a particular method or perhaps multiple methods are favoured on a case-by-case basis depending on local values, humaneness and

economic feasibility (Fitzgerald 2009; Farnworth et al. 2014). This approach is consistent with findings overseas, such as in the UK, with which New Zealand has strongest cultural roots (Bremner & Park 2007).

Changes in attitudes might reflect topical issues of the time. In 1994, these included the management of the feral Kaimanawa horse herds and the recent expansion of wasps. In 2012, these included the use of 1080 and small predator control. For the new question on methods of introduced animal control over large 'mainland' areas, very few people (<1%) believe doing nothing is acceptable, but preference tends to be for ongoing low-cost control operations rather than expensive one-off eradications. This result reflects studies overseas where people have also expressed reluctance about eradication as a management option (García-Llorente et al. 2011). But this question could be construed as overly simplified, as management of introduced animals in this context is usually a combination of one-off eradication followed by ongoing low-cost control of reinvasion. Furthermore, respondents may not have adopted strict definitions of eradication in the island context, and instead considered control to zero density a type of 'eradication' (e.g. Russell et al. 2009). Respondents may also have considered individual-level mortality (e.g. hunting) a type of control, when in the biological sense, control must translate to a population-level reduction. Essentially, harvesting animals recreationally or commercially may not control the population, but nonetheless be colloquially interpreted as a type of 'control' action (Jones et al. 2012).

This survey, and its comparison with an almost identical survey in 1994, provides a snapshot of the attitudes of New Zealanders to introduced animals and their management, and how those attitudes have changed over close to 20 years. New Zealanders still adopt a utilitarian rather than protectionist attitude to introduced wildlife and continue to follow global trends in biodiversity and conservation management, such as with respect to poison-use and animal welfare. Changes since 1994 include New Zealanders identifying positively with a greater diversity of native species, and developing unique environmental

attitudes compared with other countries. As in other Australasian studies, environmental attitudes varied by public demographics such as gender and residence (Fitzgerald et al. 2007), and indeed there is no single 'public' (Fitzgerald 2009). However, some attitudes towards the introduced animals in this survey, particularly widespread ones, and their control methods, have remained static or changed only slightly. This is despite substantial advances in the biological science underpinning introduced wildlife control and major refinements in the technology and methods for introduced wildlife control (Clout & Williams 2009). Such methodological development is important, and perceived as important, since this study and others have found traditional control methods are generally least favoured (Fisher et al. 2012). However, when presented with a selection of possible control tools, respondents generally select multiple ones (even if not prompted), and although biocontrol was favoured in and of itself, when contrasted with existing traditional methods, it is less favoured. Resilience in attitudes should not be surprising as environmental attitudes are slow to change and only weakly linked to environmental knowledge (Fransson & Gärling 1999), and usually social attitudes are what drive the implementation of science and technology (Upham et al. 2009). Generally, information campaigns rather than structural change are preferred for changing environmental behaviour (Upham et al. 2009), reflecting a common perception that conflicting attitudes are due to a deficit in knowledge. Considerably less work in New Zealand compared with overseas has focused on how social attitudes to introduced animals and their management are formed. Most work has tended to focus only on surveys of prevailing attitudes to topical issues (Fraser 2006), and lacked theoretical underpinning (Fitzgerald et al. 2007) which is crucial to progress in the field (Upham et al. 2009). A lack of knowledge on how and why people value introduced animals can generate conservation conflict that requires conflict management approaches drawing heavily on social sciences (Redpath et al. 2013).

This survey could be repeated in the future, to both improve representativeness and provide additional information on how attitudes continue to

change. This would be particularly useful as the demography of New Zealand changes with a predicted ageing population (over-represented in the current survey) and greater numbers of Māori, Polynesians and Asians (under-represented in the current survey). Alternative or additional sampling strategies may be required to access under-represented demographics. The survey might also present a means to track the outcomes of any social or physical interventions. The existing results of the survey also provide material for further in-depth research into specific elements of attitudes to introduced wildlife and their management. Additional work might include comparison of current introduced animal management budgets and prevalence of the control techniques to those considered appropriate by New Zealanders. More in-depth social attitudes work could also be undertaken, including surveys specifically understanding how attitudes are formed, or with personal or group interviews that give a deeper insight into some issues and the conflict that arises from them (e.g. Wilkinson & Fitzgerald 2006). Meanwhile, the data from this study can be used by policymakers, wildlife managers and scientists to make evidence-informed decisions on the future direction of introduced wildlife management in New Zealand.

Supplementary files

Supplementary file 1: 2012 survey.

Supplementary file 2: Summary data notes.

Supplementary file 3: 1994 and 2012 summary data.

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