Public Attitudes toward Possum Fertility Control and Genetic Engineering in New Zealand

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Landcare Research Science Series No. 29

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1. Summary

Fertility-based biological controls for possums are being developed that are likely to involve the use of genetic engineering (GE). Our previous research suggested that fertility control would be the form of biological control of possums most acceptable to the New Zealand public. A telephone survey of a representative random sample of 1002 New Zealanders was carried out in March and April 2001 to determine what form of fertility control would be the most acceptable. This publication describes the results of our survey.

People perceive that there is a possum problem in New Zealand, especially for the natural environment. Current methods of possum control are increasingly unacceptable and new methods are seen as being required.

Fertility control is highly acceptable to the New Zealand public. However, the need for a method of delivering a fertility control that involves the use of GE appears to reduce the acceptability of the control.

If a fertility control is developed, the use of genetically engineered organisms to deliver it will be acceptable to less than half of the public. If the most acceptable form of fertility control (interfering with fertilisation) is packaged with the most acceptable form of genetically engineered delivery organism (a plant), it would be acceptable to just under two-thirds (64%) of the public. Given the widespread acceptance of fertility control, the acceptability of a particular control package is likely to be determined largely by the acceptability of the delivery method used.

A fertility control that did not involve GE would, on the other hand, be acceptable and publicly supported, and is likely to receive support from those who would otherwise actively oppose a GE-based control.

2. Introduction

The Australian brushtail possum (*Trichosurus vulpecula*) is a major pest in New Zealand, presenting a serious threat to the nation's indigenous forests and damaging agriculture as a vector for bovine tuberculosis (Tb). The control of pests, particularly mammalian pests such as possums, is not just a technical issue, it is also a public issue. In 1994, when Landcare Research was commencing work on biological control for possums, we (the authors) were commissioned by the Ministry of Agriculture, through the former Institute for Social Research and Development, to investigate public attitudes toward possums and possum control in New Zealand, and in particular the potential use of biological control methods. Our aim was to determine the likely public response to biological control in comparison with other, currently used, methods of possum control, such as shooting, trapping, and poisoning. We also wanted to find out what form of biological control people would prefer.

The results of this research were reported publicly in Fitzgerald et al. (1996, 2000). This previous research found that, generally, the acceptability of biological forms of control, using, for example, parasites, bacteria, or viruses, was less than that of shooting and trapping but greater than that of poisons. By far the most acceptable method of biological control in 1994 was one that "stops possums breeding", in other words, a fertility control. Landcare Research and other research agencies then concentrated on developing fertility controls for possums.

After several years of initial research on possum fertility control, which identified various possible forms of control, new questions began to emerge. Which method of fertility control was the most acceptable to the public? How should it be manufactured and delivered? Would the use of genetic engineering (GE) be acceptable and, if so, under what conditions? To answer these questions, a further round of research was initiated in 1999. At the same time as these questions were being posed and this social research was being initiated, Government was initiating a Royal Commission to examine the increasingly contentious issue of genetic engineering, and what stance New Zealand should adopt on field trialling and release of genetically engineered (GE) organisms.

The first stage of this work consisted of qualitative research to identify the range of views about possum fertility control and the role of GE. This involved a series of focus groups in November 1999 with groups with a particular interest in possum control, and with sections of the public. This work formed part of an investigation by the Parliamentary Commissioner for the Environment (PCE), in association with Landcare Research and AgResearch, into the implications of fertility-based control of possums and the possible use of GE. The results were presented in 2000 in a report by the office of the PCE (PCE 2000), and to the Royal Commission on Genetic Modification (Wilkinson 2000).

Having determined the range of views about possum fertility control and the role of GE, the research then focused on assessing how widely those views were held by the New Zealand public. This involved a national survey, conducted in March and April 2001. In the survey, respondents were asked about their perception of the nature and extent of the possum problem in New Zealand, their perceptions of various methods for the fertility control of possums, including the method of delivery of the control, and their likelihood of taking any action in support of or opposition to the introduction of such controls.

This publication summarises the results of the focus groups and describes in detail the results of the survey.

3. Method

As with any research on public perceptions of new or contentious technology, assessing the public acceptability of fertility-based biological control technologies for possums requires a gauging of both the range of views and how widely they are held. Identifying the range of views is a qualitative research task; determining how widely the views are held requires a quantitative survey and is appropriately done after the range of views has been identified.

Focus groups

We used focus groups for the qualitative research. The focus group methodology has been in use by social scientists for over 50 years, having been first reported by Robert Merton and Patricia Kendall in 1946, and developed by Merton, Paul Lazarsfeld, and others in subsequent decades.

The focus groups for this study were chosen on the basis of our experience from previous research, which identified which sections of the population were likely to hold qualitatively different views on such issues. The groups and the name by which they are referred to in this report, were:

- Urban public women, Auckland (Women, or W);
- Urban public men, Auckland (Men, or M);
- Mixed provincial public, Levin (Provincial, or P);
- Scientists and health professionals, Wellington (Scientists, or S);
- People with ethical interests, Palmerston North (Ethics, or E);
- Industry practitioners, Christchurch (Industry, or N);
- Opponents of genetic engineering, Wellington (Opponents, or O);
- People with conservation or environmental interests, Auckland (Environmentalists, or C);
- South Island iwi group, Christchurch (Iwi, or I).

All focus groups were held in October and November 1999. The special-interest-group members were recruited directly, while the public group members were recruited through schools, based on the demographic characteristics of their neighbourhoods. Participants in these groups were recruited by their school's parents' association. The focus-group discussions generally lasted from 90 to 120 minutes, and were audio-taped. For each group, a standard set of questions was put progressively to the group by the moderator (Appendix 1), accompanied with supplementary questioning to elicit detailed or further comment. Each of the groups was attended by a possum-control research scientist, to answer any technical questions raised.

The analysis of these discussions followed the procedure developed by us in previous focus group studies, based on suggestions from Krueger (1990). This consisted of: listening to the tapes of each group in conjunction with the written notes; preparing annotated discussion-flow diagrams of each focus group; then constructing a consolidated hierarchical topic-based listing (with direct quotations and annotations, coded by group) of all the points made in the focus group discussions. In this report, comments from the participants are indicated by italics, and are faithful to the language used by the participants.

Survey

The survey involved a final random sample of 1002 adult New Zealanders and was conducted by telephone. It was geographically stratified so that every household in New Zealand that was listed in a New Zealand telephone directory had a theoretically equal chance of selection.

The questionnaire we developed was based on our previous experience of designing similar questionnaires (Fitzgerald, Saunders & Wilkinson 1996; Wilkinson & Fitzgerald 1998), and was informed by the results of the focus groups we conducted in late 1999. It went further than previous questionnaires, by asking in much greater detail than before how respondents perceived various aspects of the fertility control of possums, including the use of GE (Appendix 2). All but one of the questions were closed and pre-coded. The draft questionnaire was subjected to three rounds of field pretesting, including debriefing of the pilot respondents on the questions, their meaning, and the answers provided, to arrive at the final survey instrument.

The questionnaire differed from our previous questionnaires on similar topics by describing the possum control methods in some detail, to ensure the respondents had some understanding of the control methods they were being asked about. This was obviously important for the fertility control methods and the delivery methods, because there were subtle differences between the methods. And, because questions about these methods were preceded by a description of how they worked, we prefaced questions about the more familiar control methods of trapping and poisoning with similar descriptions. Thus, where in the 1994 survey we had simply asked about the acceptability of "trapping", in the 2001 survey we described how the possum was trapped and how it died.

We recruited and trained a team of 24 interviewers. The telephone interviews were carried out during evenings (6.30 p.m. to 9.30 p.m.) and in the daytime on weekends between 6 March and 25 April 2001. The average time for administration of the questionnaire was 21 minutes. Coding, data entry, and analysis were carried out by the members of the research team. The SPSS statistical package was used for analysis, although nonparametric multiple comparisons (Friedman, Kruskal-Wallis) were done manually using methods described in Siegel & Castellan (1988).

Although many of the measurement scales used in the survey could be considered interval scales (in that the points on the scale are equidistant numbers and only the end points are labelled), the distribution of responses often departed substantially from the normal distribution assumed by parametric statistics. Consequently, we have tended to report non-parametric statistics, in particular the Spearman rank order correlation coefficient (r_s), the Mann-Whitney U test for two independent samples, the Friedman two-way analysis of variance by ranks (F_r), and the Kruskal-Wallis one-way analysis of variance by ranks (H). Sometimes we have provided means, because they are a useful summary of the data whatever the distribution, but we have not generally compared means using parametric statistics. Levels of significance were set at the 1% level ($P < 0.01$), which reduces the chance of spurious results when large numbers of statistical tests are undertaken.

The 95% confidence interval for the estimates of the percentage of respondents quoted in this publication is plus or minus 3 percentage points. This interval is commonly called the "margin of error". It holds for 1002 respondents, and for estimates of between 20 and 80 percentage points. (For estimates of 6–19% and 81–94% it is 2 percentage points, and for estimates of 1–5% and 95–99% it is 1 percentage point.)

The sample frame consisted of all New Zealanders aged 18 and over living in households with a telephone number listed in the published Telecom telephone books that were current in February 2001. The sample frame, therefore, excluded listed businesses, cellular phone numbers, persons living in households with unlisted numbers, and persons in households without a telephone. A two-stage sampling method was applied to arrive at the sample:

1. a random selection of qualifying households, with the sample stratified according to the number of qualifying households in each region (telephone book area), then
2. a random selection of individuals within the selected households made on the basis of birthday (i.e., the person who normally lived in the household aged 18 and over who had the most recent birthday) once telephone contact had been made.

In drawing the numbers for the stratified household sample, allowance was made for changed numbers or disconnections, no answers, and refusals. In the case of no answers, messages were not left on answering machines, and up to two further attempts at contact were made. Where the target individual was unavailable, up to two further attempts were made to contact the particular person, and where possible, appointments for callbacks were made.

Pilot testing had indicated that some form of inducement might be required to achieve a reasonable response rate. The inducement offered was the chance to win one "mystery weekend" holiday. The survey explanation and recruitment rubric can be seen on the questionnaire (Appendix 2).

The overall response rate, that is the number of successful interviews as a proportion of actual contacts made with the targeted individuals, was 37% (Table 1). However this varied by region.

Table 1. Survey sample and response rates

Phone book area	Total numbers called	Defunct number	No answer	Refusal	Completed interview	Response rate % *	% of final sample
Northland	147	7	44	59	37	39	3.7
Auckland	1279	139	311	559	270	33	26.9
Waikato	296	10	81	121	84	41	8.4
Bay of Plenty	211	16	50	70	75	52	7.5
Gisborne	42	0	12	19	11	37	1.1
Hawke's Bay	123	1	26	53	43	45	4.3
Taranaki	121	6	41	44	30	41	3.0
Wanganui	92	5	23	47	17	27	1.7
Manawatu	142	13	39	54	36	40	3.6
Wairarapa	50	3	18	15	14	48	1.4
Wellington	392	22	94	171	105	38	10.5
Nelson & Bays	103	0	22	53	28	35	2.8
Marlborough	18	0	3	2	13	87	1.3
West Coast	39	0	16	13	10	44	1.0
Christchurch (& districts)	559	37	128	269	125	32	12.4
Timaru & Oamaru	72	5	15	28	24	46	2.4
Otago	205	23	29	102	51	33	5.1
Southland	117	7	18	63	29	32	2.9
Total	4008	294	970	1742	1002	37	100.0

* completed interviews as a percentage of those actually contacted

4. Profile of the Respondents

Demographic characteristics

Age & sex

Of the 1002 survey respondents, 49% were male and 51% percent female. This is close to the distribution of the New Zealand population aged 18 years and over, as recorded in the 2001 Census of Population and Dwellings (48% male, 52% female). However, the proportion of male to female respondents varied by phoning area: 55% of the sample from the three main urban areas was male, while males made up 48% of the sample from the remaining survey areas.

Compared with the New Zealand population in 2001, the age profile of the respondents (Figure 1 & Appendix 3, Table A1) was skewed in favour of those in the 40–49 age group, while those aged under 30 were under-represented. This skewing may be due to a combination of chance, the difficulty of catching younger people at home, lack of listed numbers for flats, and a possible intolerance of younger adults to being surveyed. On the other hand, the over-representation of middle-aged persons may reflect their accessibility during the calling hours, and possibly a greater interest in the issue under study. As will be seen in the results section, the difference in age distribution between the survey and the New Zealand population appears to have had little effect on the results, since age does not emerge as a significant demographic variable.

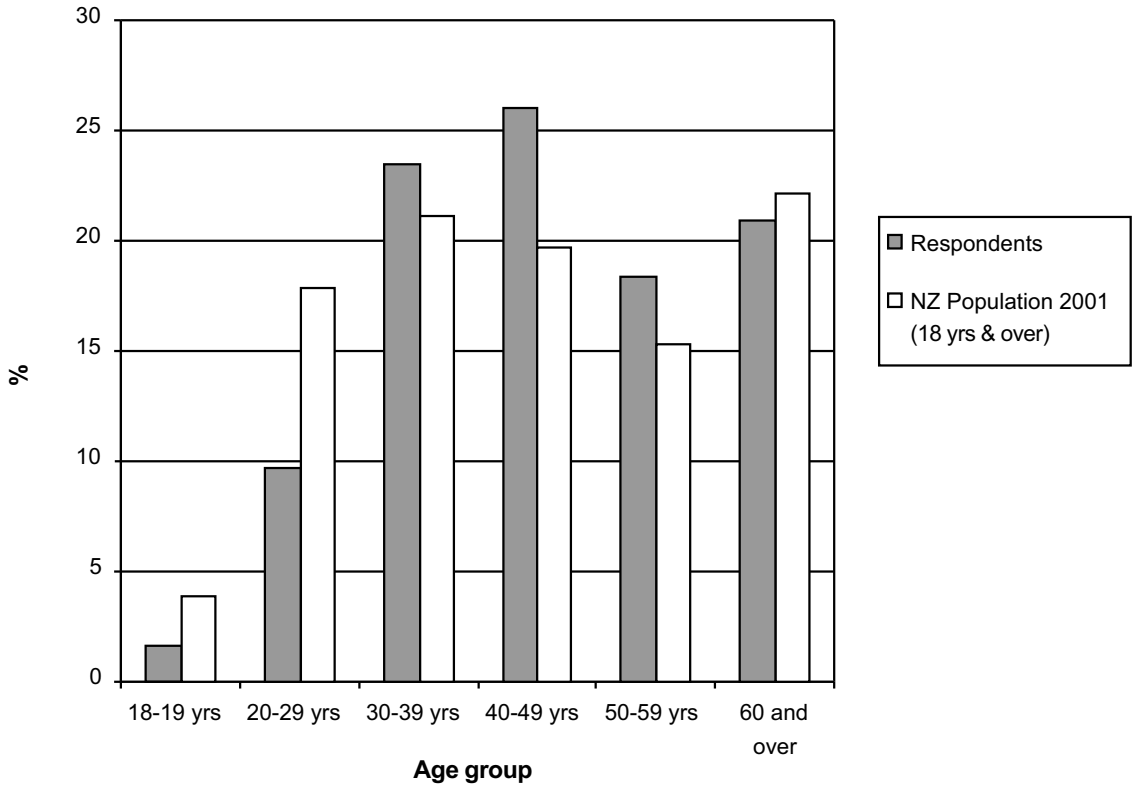

Figure 1. Age profile of the respondents

Education

The survey respondents tended to have higher levels of formal education than the New Zealand population as a whole, as recorded in the 2001 census (Figure 2 & Appendix 3, Table A2). The higher educational status of those in the sample is particularly evident in the percentage of those with university degrees and vocational qualifications, and the lower representation of those without qualifications. (Note that the census figures include those aged 15–17, and who are therefore less likely to have school qualifications than those aged 18–19).

Just over 16% of the respondents indicated they had studied genetics at some time, either formally or informally. As might be expected, a relatively high percentage of those who had studied genetics had university degrees.

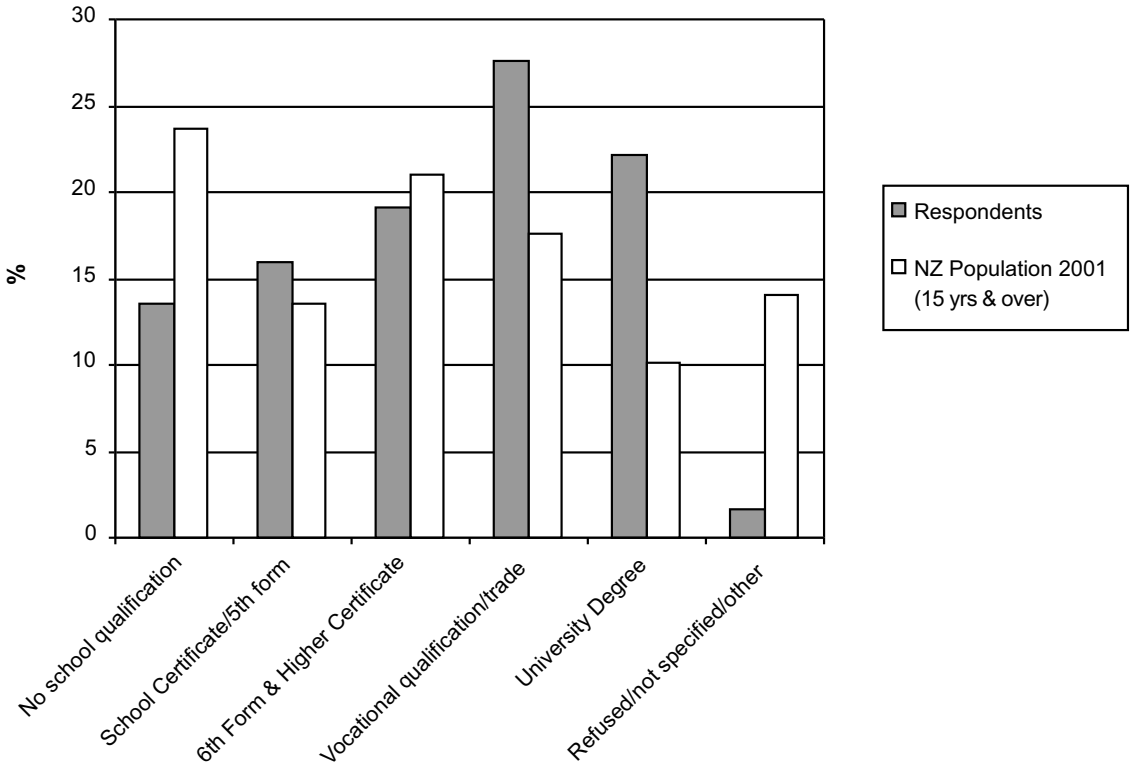

Figure 2. Educational profile of the respondents

Occupations

Generally the sample is reasonably representative of the New Zealand population (aged 15 and over) in terms of occupation. Figure 3 indicates there was an over-representation of persons in white collar (legislative/administrative/ managerial and professional) occupations, as well as primary sector workers (agriculture, forestry and fishing). Clerks and sales-or-service workers were under-represented. Compared with the general population there were considerably fewer respondents not in the active workforce, though the census figures for 2001 include persons aged 15–17 (excluded from our survey), and therefore likely to be full-time students.

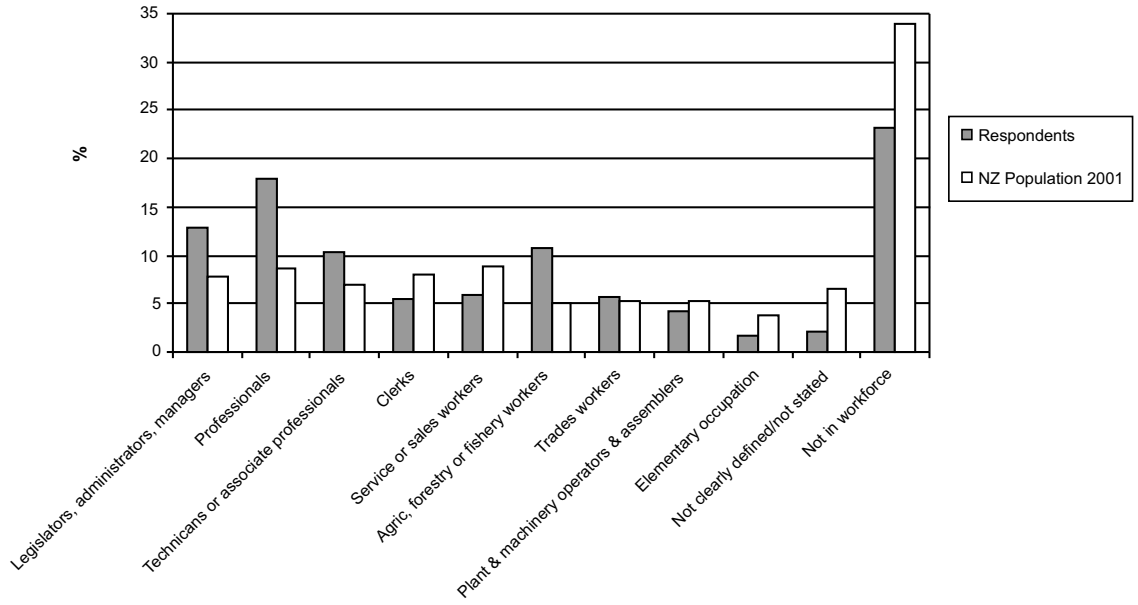

Figure 3. Occupational profile of the respondents

Residence

Seventy-three percent of the sample were North Island residents, and the remainder were from the South Island, Stewart Island and the Chathams. This is very similar to the distribution of the New Zealand population (aged 18 and over), as recorded in the 2001 census. Sixty-eight percent of the respondents classified themselves as urban residents, and 31% rural residents. This assessment of residence was subjective, and therefore no comparative figures are available for the New Zealand population as a whole. However, this urban/rural distribution is similar to that of our 1996 nationwide survey into rabbit biological control, in which 71% of the respondents indicated they were urban residents. The approximate regional distribution of the respondents is presented in Table 1.

Just over three-quarters (78%) of the respondents reported they had some experience of rural life, with 4% having owned or worked on a farm, 22% having lived in a rural area, and 52% having had experience both of owning or working on a farm and living in a rural area. This level of experience of rural or farm life is consistent with our previous surveys and indicates that, despite their current residence, many respondents have possibly been directly exposed in the past to the issues of possums in the New Zealand environment and their impacts on agriculture.

Membership of organisations

Twenty percent of the respondents indicated they were members of either an environmental or conservation group or organisation, or an animal welfare group or organisation. Overall, 5% belonged to both types of group, 11% belonged to an environmental group only and 5% belonged to an animal welfare group only. Membership of such groups appeared to be independent of age and rural or urban residence, though females tended to have a higher level of membership compared with males (23% cf. 17%). In addition, those with the highest educational qualifications had the highest levels of membership (e.g., 30% of those with university degrees were members of either or both types of group).

Previous involvement in environmental and animal welfare issues

To help assess their likely actions on any proposed fertility control for possums, respondents were asked about their previous activities relating to conservation or environmental issues and to animal welfare issues. They were asked whether they had tried to convince people they knew to take a position, signed a petition, attended a meeting, or written a submission. In all, 69% of the respondents had taken at least one of these actions in favour of the environment or conservation, and 58% had acted in favour of animal welfare on some issue (Table 2).

Table 2. Past actions on environmental and animal welfare issues

In the past few years have you . . .	% of respondents
tried to convince people you know to take a pro-environment position	57
signed a pro-environment petition	46
attended a pro-environment meeting	18
made a pro-environment written submission	16
tried to convince people to take a position in favour of animal welfare	47
signed a petition in favour of animal welfare	39
attended a meeting in favour of animal welfare	11
made a written submission in favour of animal welfare	8

Overall, 49% of the respondents reported that in the recent past they had acted in favour of both the environment and animal welfare, while 20% had acted only in favour of the environment and 9% only in favour of animal welfare.

Previous involvement in the various forms of pro-environment action was correlated (but not totally coincident) with membership of an environmental organisation. Likewise, previous action on animal welfare issues was correlated with membership of an animal welfare organisation (for both environment and animal welfare, Spearman's Rank Correlation, $P < 0.001$ for each form of action). The members of organisations were particularly likely to attend meetings and write submissions.

Extent of previous involvement

As noted, over two-thirds of the respondents reported they had some past involvement in environmental issues, the most common form being trying to convince others to take a pro-environment position, followed by signing a petition. Overall, 25% of the respondents had taken one pro-environment action, 25% had taken two actions, 13% three actions, and 6% had taken all four forms of action. On animal welfare issues, 26% of the respondents had taken one action in favour of

animal welfare, 21% two actions, 8% three actions, and 3% had taken all four actions. There appeared to be a lower level of past involvement in animal welfare issues than in environmental issues: those who had taken some action over animal welfare had taken an average of 1.8 actions each, compared with the 2.0 actions each for those who had taken action over environmental issues.

As might be expected, the extent of previous involvement in environmental and animal welfare issues (indicated by the number of types of action taken in the past) was correlated with membership of such organisations (Spearman's Rank Correlation r_s = 0.32 and 0.31 respectively, $P < 0.001$). Level of involvement in environmental issues was directly related to level of education (Spearman's Rank Correlation $r_s = 0.32$, $P < 0.001$).

For the purposes of further analysis, an "activist" was defined as someone who had both tried to convince others and signed a petition (about equally prevalent and the easiest forms of action), or who had attended a meeting or made a written submission on an issue. Using this criterion, 45% of the respondents were environmental "activists", and 32% were animal welfare activists. When taken together, 54% of the respondents could be considered environmental or animal welfare "activists".

Comparison with Royal Commission's survey

As part of its deliberations, the Royal Commission on Genetic Modification commissioned a survey of the New Zealand public, to canvass public opinion on various issues around genetic engineering. The survey was conducted for the Royal Commission by a market research firm. It involved a nationally representative sample of 1153 New Zealanders, 15 years of age and over, and was conducted by telephone between 22 March and 8 April 2001 (RCGM 2001, Appendix 1, pp 154–155). The respondents were roughly as representative of the New Zealand population as those in our survey, in age, location, and education (RCGM 2001, Appendix 1, pp 186–196). However, the sample was biased towards females (58%, compared with 51% in our survey). This suggests that, given the tendency of females to be more negative toward genetic engineering, the Royal Commission's survey would slightly understate the acceptability of genetic engineering. In this report, relevant results from the Royal Commission's survey are compared with the results of our own survey.

5. Perceptions of Possums and Possum Damage

Focus groups

Each focus-group discussion commenced with a question about whether participants thought there was a problem with possums and, if so, what should be done about it. The focus-group participants generally (but not universally) agreed that possums were a problem in New Zealand and they needed to be controlled. Some participants suggested it was not clear what exactly the problem was with possums: *we need to debate whether there is a possum problem and what the issues are and the adequacy of current controls, before we debate new controls* (N).

Possums were seen mainly as a threat to New Zealand's environment. They ate native vegetation in preference to exotic (seeing it as *ice cream* — S), causing extensive damage to some native plant species in urban reserves as well as more extensive forests. They were seen to *take out fruit, this puts pressure on native birds* (S), depriving them of a food source, and also *eat eggs and young of native birds* (I). The need to prevent further damage to New Zealand's native species — and thus its biodiversity — was seen as the strongest grounds for controlling possum numbers: *the issue is what they do to the overall health of habitats and communities, not just individual species* (S). Possums were also seen as a threat to plantation forestry, horticulture, and crops: *my parents planted 4000 trees, possums ate them all in one night* (O).

Damage caused by possums spreading bovine tuberculosis (Tb) was seen as a separate issue to, and less important than, the environmental damage issue. It was seen as a localised issue, a strong concern for the farming community and relevant authorities. The Scientists group spoke more about Tb eradication as a goal for possum management than did the other groups. Participants in more than one group expressed concern that current possum control was aimed at Tb control rather than conservation: *the government is only worried about Tb and bush next to farmland* (P). As the Industry group pointed out, the environmental and animal health (Tb) goals of possum control tend not to sit well together, because the possum control effort is seen as greatest in areas where Tb is an issue, and these are not the areas requiring biodiversity protection.

Survey

Respondents were offered three statements about possums in New Zealand and asked to indicate which statement best described their view. Almost all (96%) agreed that possums are a problem. This included those who also agreed that new forms of control are required (83% overall) and those who also agreed that current control methods are adequate (13%). Only 2% felt that possums were not a problem. The remaining 2% said they didn't know. These findings are consistent with those from 1994, when 93% agreed with the statement that "possums are a problem in New Zealand".

The respondents were also asked to rate on a 5-point scale how much of a problem they considered three kinds of possum damage to be, and to give an overall rating (Table 3). The damage to the natural environment was rated as the most serious of the problems listed (i.e., 87% rated it 4 or 5 on the scale). Forty-four percent rated the damage to overseas trade caused by Tb infection of cattle and deer as a serious problem, and the damage to people's gardens was seen a serious problem by 25%. Overall possum damage to New Zealand was considered serious by 78%. Ignorance about the impact of possums was greatest in regard to damage to overseas trade (18% indicated they did not know enough to be able to rate the seriousness of the problem).

Table 3. Perceptions of the damage caused by possums (n=1002)

Type of possum damage	% of respondents					
	1	2	3	4	5	
	No problem				Major problem	Don't know
Damage to NZ native bush and birds	1	2	9	23	64	1
Damage to overseas trade by Tb	2	10	26	17	27	18
Damage to people's gardens	19	26	27	11	14	3
Overall damage to NZ	1	5	15	35	43	1

The views on possums in New Zealand and the ratings of the seriousness of the problem of various kinds of possum damage appear to be independent of respondent characteristics such as residence, age, sex, education, membership of environmental and animal welfare groups, and being an environmental or animal welfare "activist" or not.

The impact of possums on the environment remains the principal concern of the New Zealand public, rather than the impact on agricultural production and trade. In the 1994 survey, 95% and 80% of the survey respondents, respectively, agreed that possums presented "a threat" to "New Zealand's native bush" and to "New Zealand's birdlife", while 70% agreed possums represented a threat to New Zealand's overseas trade. However, in the current survey a considerably lower proportion of respondents (44%) regarded the impact on overseas trade as an important issue. The level of ignorance of the impact of possums on overseas trade (indicated by the percentage of "don't know" responses) was very similar in this survey to that recorded in 1994 (18%, cf. 13% for trade and 17% for Tb in 1994).

6. Knowledge of Genetic Engineering and Willingness to Learn

In the survey, respondents were asked the extent to which they had heard of "genetic engineering". Almost all the respondents (97%) had at least heard of it, but the extent of their understanding varied: 25% felt they knew "little or nothing about it", 40% knew "something about it", 28% felt they knew enough to "probably explain it to a friend", and only a small percentage (4%) indicated they had studied it and had "a good understanding of its technicalities". As noted earlier, only 16% of the respondents reported having ever studied genetics.

In the Royal Commission's survey, 95% of respondents had heard of "genetic modification", "genetic engineering" or "GE" (RCGM 2001, Appendix 3, pp. 199–202), a similar result to our own. Responses to the Royal Commission's survey question about how informed respondents believed they were about genetic modification are not strictly comparable with our related question because the categories are different. Of the 95% who said they had heard of the term, 13% were "very uninformed" about genetic modification, 23% "just uninformed", 6% "neither", 50% "just informed", 7% "very informed", and 1% said they "don't know" (RCGM 2001, Appendix 3, p. 225).

As might be expected, there was some correlation in our survey between having studied genetics and the extent of a person's claimed knowledge of genetic engineering, and both were generally associated

with the extent of the respondent's educational qualifications. Extent of knowledge of genetic engineering does not appear to be correlated with any demographic characteristics of the respondents.

Willingness to learn about GE (and its possible application in the control of possums) was indicated by the respondent's stated likelihood of attending a meeting to learn about it. Thirty-six percent indicated that it was likely that they would attend such a meeting. Four-fifths of these respondents were also likely to attend a meeting to learn about a non-GE fertility control, indicating that their interest extends to the broader issue of fertility control. Overall 34% of the respondents indicated they would be likely to attend such a meeting.

There was no clear statistical relationship between likelihood of attending a meeting to learn about GE control and the demographic characteristics of the respondents.

7. Acceptability of Possum Control Methods

Focus groups

The most widely used poison at present, 1080 (sodium monofluoroacetate), was seen by the participants in several focus groups (mainly the public ones) as dangerous. Concerns about its getting into the water supply, leaving residues in the environment, and killing dogs and other animals were mentioned. Public antipathy towards the use of 1080 was recognised in several special-interest focus groups, along with the risk to New Zealand's image overseas if it continued to use 1080: *If New Zealand is the major user of 1080 worldwide, the image of the nation may be an important issue. People outside New Zealand looking in might say "wow, they use a lot of 1080 down there, don't they, that place must be toxic"* (E). It was recognised, however, that poison application methods had improved: *when 1080 first came out, you stuck it on a carrot and dumped it out of an aircraft flying really low, that dropped 3 tons in ½ ha. Now we know we can kill a possum with a very small amount of 1080 on a cereal bait* (C). Participants made few comments on poisons other than 1080.

Shooting and trapping were seen as neither practical nor effective: *have to lay a lot of traps* (W); *trappers can never get into inaccessible places* (I). They posed risks to other animals, and to people: *shooting involves night work* (S); and *traps catch other animals* (W). Shooting and trapping were associated by some participants with the idea of making productive use of possums. Possums produced meat, provided employment, and could be the basis for a fur industry. Using their products was seen as providing an added justification for killing them. Some participants were strongly in favour of a bounty on possums: *the easiest way to eliminate a species is to make it worth money* (P). However, the argument for making productive use of possums was countered by participants in several groups as not feasible and working against achieving control: *the sums don't stack up for trappers unless they are already being paid to kill them* (N); *people will only kill while it is economically viable* (C); *people won't trap them all, they want to keep the source of their livelihood* (I).

Interfering with fertilisation by rendering possums sterile was widely acceptable. The *women's view* was considered by a woman in the Iwi group to be *important when considering altering breeding* and, in that group, stopping them breeding was described as *a good option*. The Women's group agreed: *stopping them producing babies would be better than killing babies. Something can just live out its life and just not have babies*. The Industry group evaluated it in terms of its perceived public acceptability: *more acceptable to the public, possums die of old age*. Sterilisation was not, however, acceptable to all participants, with some, particularly among the Scientists, expressing concerns about it. It *requires an extra generation to control them*, and *they will probably reproduce faster than they*

can be controlled (S). *Will it just push them into areas they haven't predated yet?* (S). And, *extrapolated to other populations,* [sterilisation] *becomes an emotive issue* (S). For example, the Women's group speculated on whether the fertility control agent might get into farm animals, or even human hunters. Contraception, a fertility control related to sterilisation, was, despite being seen as *more acceptable to the public* (S), observed to be *a problem for some people* (C).

The fertility control that interfered with breeding hormones (and which was described as not involving genetic engineering) was evaluated favourably, simply because it did not involve genetic engineering: *if it could be specifically targeted to possums, on paper it looks the best biocontrol because it's not GE* (O); *one is natural, and the others are genetically modified* (W). The Opponents group was particularly in favour of it: *it's inert, it doesn't reproduce, doesn't have the potential to take over the environment, people are more in control*. Both the Scientists and the Industry groups evaluated it favourably because they saw public opinion as being against genetic engineering: *no genetic engineering, which public perception could be against* (S); *easier to sell possum biocontrol to the public without GE* (N). Questions were raised about its specificity to possums in several groups: *how selective is it?* (S); *how much hope is there of something specific to possums?* (O); *could you make it specific to possums?* (P). The Women's group, while observing that it was *natural*, whereas the other controls were *genetically modified*, warned that they *still need the same guarantees though*, they *need an absolute guarantee that it won't affect anything else*.

The most consistently expressed criterion for the acceptability of a fertility control for possums, as with all control methods, was that it was "safe". Overwhelmingly, "safe" meant "specific". People's greatest fear, whether for biological controls generally or for individual fertility control methods, was that they might affect other species (including domestic and farm animals, and humans), either immediately or because of some future mutation or loss of species specificity. A very high degree of certainty about the specificity of a fertility control was commonly felt to be a necessary prerequisite for its use: *need to be absolutely certain it won't have ramifications on the environment, other species, or people* (S); *if you could give a 100% guarantee that it would not spread to another species, you would most probably find that everyone would just about agree with it* (P).

Another perceived determinant of the acceptability of a fertility control was that it was humane. Participants presented a wide variety of views on humaneness, from *if it's a quick death it's not so bad* (W) to *humaneness is important for us as people, but they are possums!* (W). In contrast to their requirements about specificity (which were absolute), participants often spoke of the need for humaneness in relative terms. Nobody asked for a 100% guarantee of humaneness. One relativity was between the harm caused by possums and the harm caused by killing them: *There's a certain degree of suffering that I'm not prepared to put a possum through, even though it is a possum and I believe all possums should be got rid of* (I). Another was between widely different methods of killing them: *What's the difference between a possum hunter killing one with a joey in the pouch, and introducing a parasite or transgenic plant that does the same job? Do the ends justify the means?* (I).

In general, the focus groups endorsed the concept of fertility control, favouring interfering with breeding hormones over sterilisation because, as described to them, it would not involve the use of GE. Its acceptability would depend ultimately on its being specific and humane.

Survey

In the survey, respondents were asked how acceptable they found various methods of controlling possum numbers. Two were the most likely methods of fertility control: interfering with fertilisation (by causing the female possum to develop an immunity to its own eggs and react against them as if they were foreign) and interfering with breeding hormones (by killing the particular cells that control the production of breeding hormones in one part of the brain). The other two were the most

commonly used current methods of controlling possum numbers: trapping (using a smooth-jawed leg-hold trap) and poisoning using 1080 poison. (See Appendix 2 for full wording of the questions.)

The two methods of fertility control were both rated acceptable (scores 4 and 5 on a 5-point scale) by more than 70% of respondents (Table 4). One of them (interfering with fertilisation) was rated very acceptable by 57%. In contrast, the two current possum control methods were rated acceptable by only about 30% of respondents. (At this point in the questionnaire, the possibility that the fertility control methods may involve the use of GE had not been mentioned.) We estimate the percentage of the New Zealand adult population finding interfering with fertilisation acceptable to be 78%, plus or minus 3 percentage points, or between 75% and 81%.

Table 4. Acceptability of possum control methods (n=1002)

Method	% of respondents					
	1 Very unacceptable	2	3	4	5 Very acceptable	Don't know
Interfering with fertilisation	6	5	9	21	57	2
Interfering with breeding hormones	7	7	12	25	46	3
Poisoning using 1080 poison	27	20	21	17	14	1
Trapping using smooth- jawed leg-hold trap	28	20	22	13	17	1

The acceptability of the two methods of possum fertility control described in some detail in the 2001 survey is similar to, although slightly lower than, that of a biological control method described only as "a method that stops possums breeding" in the 1994 survey (acceptable to 83% in 1994; unless otherwise stated, all results from the 1994 survey are taken from Fitzgerald et al. 2000).

The acceptability of poisoning using 1080 is similar to that measured in our 1994 survey (ground laying of 1080 acceptable to 36% in 1994, aerial drops of 1080 acceptable to 27% in 1994). However, the acceptability of trapping is much lower (acceptable to 67% in 1994). This seems to be because trapping was described in the 2001 questionnaire in the following terms: "the possum is attracted by a lure and caught in a smooth-jawed leg trap. It is then killed within 24 hours". The 1994 survey merely mentioned "trapping" without elaboration, and it is possible that 1994 respondents may have been thinking of other forms of trapping, such as kill traps and cage traps, or may not even have thought about the form of trapping. Note that we also elaborated on how 1080 kills possums in the current survey, but the responses were little different from those in 1994, when we did not elaborate.

There were significant differences in acceptability between the control methods (Friedman two-way ANOVA, $P < 0.0001$). Multiple comparisons within the Friedman test showed that, apart from trapping and poisoning (which were not significantly different), each control method was significantly different in acceptability from each of the others ($P < 0.01$).

Male respondents rated all the possum control methods, except for interfering with fertilisation, significantly more acceptable than did female respondents (Kruskal-Wallis one-way ANOVAs, $P < 0.0001$). There was no clear pattern of significant differences in acceptability among other demographic factors considered, although older people and people who said they had heard more about GE were more accepting of the two fertility control methods (Kruskal-Wallis one-way ANOVAs, $P < 0.01$ for hearing about genetic engineering and $P < 0.001$ for age). Given the under-

representation of 20–29 year-olds in the survey, the acceptability of the fertility control methods is likely to be slightly lower than that stated.

Because the idea of acceptability connotes a cognitive or analytical approach to what the respondents thought about the control methods, we also wanted to find out their affective response, that is, how they felt about the methods. We did this by asking them how "comfortable" they felt about each of the methods. The results were similar to the responses for acceptability. Seventy-six percent said they felt comfortable with interfering with fertilisation (ratings 4 and 5), and 69% felt comfortable with interfering with breeding hormones. For the current methods, 34% felt comfortable with trapping, and 30% felt comfortable with 1080 poison.

We also asked the respondents how "humane", how "specific to possums", and how "effective in reducing possum numbers" they thought each control method was. These were the attributes mentioned most consistently in the focus groups, in relation to acceptability. The four methods were placed by the respondents in the same order for each of the three properties as they were for acceptability, except that trapping was seen as more specific to possums than was poisoning (Table 5; for raw data see Appendix 3, Table A3). For all control methods, humaneness was the attribute most highly correlated with acceptability (Spearman's Rank Correlation r_s = 0.68, taking all control methods together), followed by specificity (0.63), then effectiveness (0.55). The rate of "don't know" responses was lowest for humaneness (1–3% of respondents for all methods), and highest for specificity (6–8% for trapping and poisoning; 18–19% for the two fertility controls), with effectiveness in between (5–6% for trapping and poisoning; 14–15% for the two fertility controls).

Table 5. Perceived properties of possum control methods (n=1002)

Method	Mean score *			
	Humane	Specific	Effective	Acceptable
Interfering with fertilisation	4.3	4.2	4.1	4.2
Interfering with breeding hormones	4.2	3.9	3.8	4.0
Poisoning using 1080 poison	2.6	2.5	3.3	2.7
Trapping using smooth-jawed leg trap	2.4	2.6	2.4	2.7

* Mean when scored on a 5-point scale from 1 "not at all" to 5 "very much". For acceptability, the scale was from 1 "very unacceptable" to 5 "very acceptable". "Don't know" responses not included.

There were significant differences between the control methods in perceived humaneness, specificity, and effectiveness (Friedman two-way ANOVA, $P < 0.0001$). Multiple comparisons within the Friedman test showed that each control method was significantly different in perceived humaneness from each of the others (except that the two fertility controls were not significantly different), the two fertility controls were significantly different in perceived specificity from the two current methods, and all controls were significantly different in perceived effectiveness ($P < 0.01$). Clearly, the fertility controls were seen as superior to the existing methods on each of the attributes.

Comparisons can be made with the results of the 1994 survey, where "trapping", "poisoning" and "biological control" were rated with respect to the ideals of "safe" (which, in practice, appears to mean "specific") and "effective" (Fitzgerald et al. 1996). In 1994, trapping was seen as closer to safe than was biological control, which in turn was seen as closer to safe than was poisoning. Differences between all control methods were significant (Fisher's Least Significant Difference, $P < 0.01$). Also, in 1994, poisoning was seen as significantly closer to effective than were trapping and biological

control. Between 1994 and 2001, trapping came to be seen as less specific, and trapping and poisoning as less effective, relative to the other methods suggested.

8. Acceptability of Possum Control Delivery Methods

Possum fertility controls need a way of producing the control substance and delivering it to the possum. This is likely to involve GE. Genetic engineering could be used in two possible ways. Firstly, an organism could be genetically engineered in a laboratory or under other controlled conditions to produce a possum fertility control substance. The organism would then be killed or treated so it cannot reproduce when released into the environment. Secondly, GE could be used to modify an existing organism so that it carries the fertility control substance. The organism would then be released alive into the environment to spread from possum to possum.

Focus groups

In the focus groups, delivery methods and organisms were discussed in the context of biological control in general, and fertility control in particular. When asked how they felt about a biological control for possums, participants discussed various organisms that could be used to control possums, as well as deliver a fertility control. Viruses were seen, particularly in the public groups, as mutable and uncontrollable: *you can't control it, it will mutate to keep itself alive* (P). Parasites and diseases in general were mentioned by participants. A preference was expressed for naturally occurring diseases of possums (or marsupials) over modified organisms, and the example of RCD in rabbits was mentioned: *I was happy to see RCD* (M); *at least RCD was naturally occurring somewhere else* (N).

The use of a GE plant to distribute a fertility control to possums was discussed in four of the focus groups. Issues raised included specificity — *we don't know what else will eat a transgenic plant* (I); risk trade-off — *is the risk worth what we are trying to do? If we use a GE plant to protect the forest, we might unleash something with more far-reaching consequences than just the possums* (S); ecology — *what would happen when there were no possums left? Will the plants take over?* (W); lack of control — *with a bait, if something goes wrong, you can just remove the bait* (W); and unforseen effects — *who's to say it won't affect the plant? It could kill off two species: one you want and one you don't* (W). The Opponents group expressed a range of concerns about a transgenic plant, including specificity — *we don't know what else might eat them, or where they might end up in the biological chain*; cross-pollination — *they say they can produce them sterile, but we know there is recombination*; horizontal gene transfer *between plants and viruses, and between viruses and who knows what*; antibiotic resistance through using antibiotic marker genes; and the generalised unknown of *wholesale release into the environment*.

Participants in public groups described their knowledge of foreign organisms introduced to New Zealand in the past. They provided descriptions of introductions, both successful and unsuccessful. These ranged from *there are dozens of examples of things we have introduced with good intentions and they have backfired on us* (M) to *they do a lot more research on how it would work now than they used to, before releasing it* (I). The possum itself had been introduced: *possums in Australia had their own natural checks and balances; nobody thought about that, they brought them here and look what happened* (W).

Ecological concerns about biological controls and the outcomes of their use were raised in some groups. *What happens when the possums are gone? Does something else explode?* (M) *How would the virus be eradicated when the possums are gone?* (W). *What happens to the parasite when the possum dies?* (M). Because of the perceived uncontrollability of a biological control organism, a

release was seen as irreversible. *Poisons are reversible, you can stop the poison drops at any time. You can't reverse biocontrols* (C).

Several groups expressed concern about the impact a biological control for possums in New Zealand might have if it spread to Australia. *Possums are a rare and protected animal in Australia, an endangered species* (O). *What will stop it spreading across the ocean? Parasites and viruses spread over the ocean. We couldn't stop it. You don't have a fence on the edge of New Zealand to stop it spreading further* (W). *You can't keep them out with border controls. We live in a globalised world, it will get across the Tasman* (C). *I would rather* [possums] *didn't become extinct here, if it meant they also became extinct in Australia* (M). The spread of a biological control to Australia might not be accidental: *Say we had a virus that made possums sterile, what would happen if somebody went to Australia with it?* (O).

In general, the focus groups showed an unease about the use of other organisms to deliver a fertility control, especially about longer-term specificity and the use of GE organisms. They were not keen to endorse the use of GE organisms to spread the control.

Survey

In the survey, separate questions were used about the forms of fertility control and the methods of delivering it. Respondents were presented with four possible delivery methods, each of which involved the use of GE. Two (A GE plant and a GE bacteria) involved the use of GE only in the laboratory. The other two (a GE parasite worm and a GE virus) involved a GE organism being released into the environment.

Although all four delivery methods were more acceptable than trapping and poisoning, they were less acceptable than the two methods of fertility control (Table 6). This suggests that respondents generally accepted the concept of fertility control of possums in principle but, when asked about the reality of having to deliver the control to the possum, they were less accepting. The need for a method of delivering a fertility control that involves the use of GE thus appears to reduce the acceptability of the control.

Table 6. Acceptability of possum fertility control delivery methods (n=1002)

Method	% of respondents					
	1	2	3	4	5	
	Very unacceptable				Very acceptable	Don't know
GE plant (killed, in a bait)	20	13	21	22	21	3
GE parasite worm (live, spread from possum to possum)	24	14	17	20	23	2
GE bacteria (killed, in a bait)	24	16	21	19	17	3
GE virus (live, spread from possum to possum)	31	16	19	16	16	2

These results are similar to those from the 1994 survey. In that survey, a parasite was acceptable to 35%, a bacteria to 29%, and a virus to 29%. There was a large percentage of "don't know" responses to those questions in that survey (14–15%). When the "don't know" responses are removed from the analysis, a parasite was acceptable to 41%, a bacteria to 34%, and a virus to 33% (Fitzgerald et al. 1996).

The two methods of biological control of possums that involved the least acceptable organisms in the 1994 survey, bacteria and viruses, were also of low acceptability in this survey. This was despite the fact that, in the biological controls examined here, the live bacteria would be confined to the laboratory and the virus would be released live. A higher percentage of respondents rated them unacceptable (scores 1 and 2) than rated them acceptable (scores 4 and 5). Both a GE plant, killed and made into a bait, and a GE parasite worm, released and allowed to spread from possum to possum, were rated acceptable by 43% of respondents, more than the percentage of respondents that rated them unacceptable, but still not a majority.

Respondents tended to be polarised in their response to the delivery methods, with more than 40% adopting an extreme position, either "very unacceptable" or "very acceptable". In the case of the virus, the extreme positions tended toward the negative, with 31% rating it as very unacceptable.

There were significant differences in acceptability between the delivery methods (Friedman two-way ANOVA, $P < 0.0001$). Multiple comparisons within the Friedman test showed significant differences in acceptability between GE plant and GE bacteria, GE plant and GE virus, and GE parasite worm and GE virus ($P < 0.01$).

Male respondents rated all the possum-control delivery methods significantly more acceptable than did female respondents (Kruskal-Wallis one-way ANOVAs, $p < 0.0001$). There was no clear pattern of significant differences in acceptability among other demographic factors considered.

Levels of comfort with the delivery methods were similar to, although slightly lower than, acceptability levels. Forty-one percent said they felt comfortable with the use of a GE plant (ratings 4 and 5), 41% felt comfortable with the use of a GE parasite worm, 35% felt comfortable with the use of a GE bacteria, and 31% felt comfortable with the use of a GE virus.

We also asked respondents how specific to possums and how effective at getting the fertility control substance into the possums they thought each delivery method was. (We did not consider humaneness of the delivery method to be relevant.) The two delivery methods that involved the field release of a GE organism (parasite worm and virus) were rated as more specific and more effective than the two methods that did not involve a field release (Table 7; for raw data see Appendix 3, Table A4). However, for both the parasite worm and the virus, the questions included statements that they were found **only** in possums, whilst the questions for the plant and the bacteria did not include any mention of their specificity, thus the observed effect might be spurious (see Appendix 2, emphasis in questionnaire).

Table 7. Perceived properties of possum control delivery methods (n=1002)

Method	Mean score *		
	Specific	Effective	Acceptable
GE plant (killed, in a bait)	3.1	3.2	3.1
GE parasite worm (live, spread from possum to possum)	3.7	3.6	3.0
GE bacteria (killed, in a bait)	3.0	3.2	2.9
GE virus (live, spread from possum to possum)	3.5	3.6	2.7

* Mean when scored on a 5-point scale from 1 "not at all" to 5 "very much". For acceptability, the scale was from 1 "very unacceptable" to 5 "very acceptable". "Don't know" responses not included.

The high perceived specificity and effectiveness of the parasite worm and virus were not reflected in their acceptability. Thus, although the plant was seen as less specific and effective than the virus, it was more acceptable. It should be noted that both the parasite worm and virus were described in the questionnaire as "found only in possums". For further analysis, the delivery methods were classified into whether they involved the use of microorganisms (bacteria, virus) or not and whether the organism would be released live into the environment (parasite worm, virus) or not. A linear regression procedure was used to identify the influences of the characteristics of the delivery organism on the acceptability of the delivery methods. Specificity was the strongest (ß = 0.45), followed by effectiveness (ß = 0.22). Not involving the field release of a GE organism was next (ß = 0.17), and last was not involving a microorganism (ß = 0.07). (Adjusted $r^2 = 0.38$, $F = 490$, $P < 0.0001$, inspection of residual plots showed the assumptions of a linear regression were not violated.) The effects of not involving the field release of a GE organism and not involving a microorganism thus appear to moderate the influence of perceived specificity and effectiveness on acceptability.

There were significant differences between the delivery methods in perceived specificity and effectiveness (Friedman two-way ANOVA, $P < 0.0001$). Multiple comparisons within the Friedman test showed that each delivery method was significantly different in perceived specificity from each of the others (except for the GE plant and GE bacteria), and the GE virus and GE parasite worm were significantly different in perceived effectiveness from the GE plant and GE bacteria ($P < 0.01$).

9. Acceptability of a Possum Fertility Control Package

In addition to the control and delivery methods described above, we asked respondents about the acceptability of a realistic or likely possum-fertility-control "package". This was based on components currently being researched, both of which had been asked about earlier in the survey interview. The package was described thus:

> Scientists are currently trying to develop a possum fertility control that involves genetically engineering a plant so that it contains a protein from possum eggs. The plant would then be killed so that it can't grow, and a bait made from it would be laid for possums to eat. The protein would cause the female possum to develop an immunity to its own eggs and react against them as if they were foreign to it. It would fail to become pregnant.

Fifty-seven percent said that such a control should be released in New Zealand, 23% said it shouldn't, 17% gave an "it depends" response, and 3% said they didn't know.

When asked for the reasons for their response, 50% gave reasons why they thought a possum fertility control was needed (Table 8). The most common of these were that possums needed to be got rid of or their numbers reduced, that possums caused damage and that damage was too great for current control methods to cope, and that fertility control sounded good or seemed humane. Few said that fertility control was not needed, mostly because they thought current methods were sufficient or were better than the proposed new methods. The specificity of the control, its host range, or its potential for mutation, was a concern for 24%. Half of all concerns about GE were not stated in detail (that is, were unspecified), while the most common specified concern was that it may have unforseen effects. Those with a risk or trust concern either raised the prospect of unforseen effects that they could not detail, required a 100% guarantee of safety, or expressed a lack of trust in science or scientists.

Table 8. Reasons for position on the fertility control package (n=985, 2231 multiple responses)

Reason category	% of respondents
Get rid of them!	27
Possum damage too big for current control	15
Fertility control sounds good	14
Fertility control a necessary evil	2
Control needed other	3
Control needed (total)	*(50)*
Specificity concern	24
Practical concern (must be well tested, regulated, targeted)	17
GE concern	12
Risk or trust concern	8
Ecology concern (e.g., vector, introduced organism)	7
More research or information required	5
Control not needed	5
Ethical concern (meddling with nature, inhumane)	4
Uncomfortable or uneasy	3

Our previous research has shown that the raw response to questions about whether a biological control (in this case, the introduction of a fertility control package) should be introduced is not necessarily a good indicator of a respondent's actual position. Further analysis, based on each respondent's stated reasons for their response, was done to deduce their position on the potential introduction of a fertility control that involved the use of GE. This showed that more than half the respondents had an unconditional position, either clearly acceptable or clearly unacceptable (Table 9), suggesting that most people had already made up their mind. A total of 64% appeared to find the fertility control either clearly acceptable or generally acceptable. This is greater than the raw measure of 57%, since we were able to deduce a position for many of those who had initially indicated a "depends" or "don't know" response.

Table 9. Respondents' position on the introduction of the example possum fertility control package (n=1002)

Position	% of respondents
Clearly acceptable	38
Generally acceptable	26
Ambivalent (both positive and negative)	8
Generally unacceptable	6
Clearly unacceptable	20
Neutral or undecided	1
Don't know	1

The acceptability of the package can also be indicated by averaging the acceptability of its components. We therefore took interfering with fertilisation (acceptable to 78%), and averaged its acceptability with that of delivery by a GE plant (acceptable to 43%). By this calculation, the package was potentially acceptable to 61% of respondents. This percentage falls close to the 57% who said that the example control should be released and the 64% whose actual position we deduced to be "generally acceptable" or "clearly acceptable".

Such a simple average assumes that the control method and the delivery method have equal weighting. However, the acceptability of the delivery method was about twice as strongly correlated with deduced position as was the control method (Spearman's Rank Correlation r_s = 0.27 for interfering with fertilisation and 0.53 with the GE plant; position scored from "clearly unacceptable " (1) to "clearly acceptable" (5), neutral/undecided and "don't know" responses removed). Given the widespread acceptance of fertility control, the acceptability of a particular control package is likely to be determined largely by the acceptability of the delivery method used.

In the Royal Commission's survey, 58% of those who had heard of "genetic modification" said they thought there were more advantages than disadvantages in using genetic modification for pest control (65% of males and 53% of females). This was the third highest rating of the eight uses of genetic modification canvassed, after "medicines and vaccines" and "medical research", both 71% (RCGM 2001, Appendix 3, p. 229). Results for approval were similar: 54% of those who had heard of "genetic modification" said they just approved or strongly approved of using genetic modification in pest control (62% of males and 48% of females). Again, this was the third highest rating of the eight uses of genetic modification canvassed, after "medical research" (65%) and "medicines and vaccines" (64%) (RCGM 2001, Appendix 3, p. 229). The results of the Royal Commission's survey are similar to our own results.

10. Potential Behavioural Responses to a Possum Fertility Control

Assessment of the respondents' potential behavioural response (called "behavioural intention" by Ajzen & Fishbein 1980) to a proposed fertility control for possums were determined by asking how likely it was that they would take various forms of (escalating) action against or in support of a GE fertility control for possums, and a non-GE fertility control for possums. The forms of action were: trying to convince friends to take a particular position, signing a petition, attending a protest meeting, and making a written submission. The results are presented separately below (Tables 10 & 11). Over three-quarters (79%) of the respondents said they would be likely (ratings 4 and 5 on a 5-point scale) to take one or more of the listed actions in support or opposition to a proposed fertility control.

Over half (56%) of the respondents indicated they would be likely to take some action in **support** of a fertility control for possums that **involved GE**. On the other side, 32% indicated they would be likely to take some action **opposing** the use of a fertility control for possums that involved GE (Table 10).

In **support** of a possum control that involved the use of GE, 39% of the respondents said they would be likely to sign a petition, 32% would be likely to try to convince their friends, 24% would be likely to attend a meeting , and 13% would be likely to write a submission. In **opposition** to a GE control, 20% of the respondents said they would be likely to sign a petition, 17% would attend a meeting, 16% would try to convince other people, and 9% would write a submission.

Table 10. Likely actions over a possum fertility control that involved genetic engineering

	% of respondents					
	1 Not at all likely	2	3	4	5 Very likely	Don't know
Actions in support of a GE control						
try to convince people you know	30	12	25	16	16	2
sign a petition	31	8	19	18	21	3
attend a meeting	45	11	18	12	12	2
make a written submission	61	11	13	6	7	2
Actions in opposition to a GE control						
try to convince people you know	51	15	16	6	10	1
sign a petition	55	11	13	6	14	3
attend a meeting	56	12	13	8	9	2
make a written submission	70	12	8	4	5	2

There were statistically significant differences between different types of respondents in terms of their declared likelihood of acting over a GE-based possum control (based on Mann-Whitney *U* tests, $P < 0.01$). Urban and rural residents were generally similar in their responses, though rural residents indicated a higher likelihood of attending meetings either to support or oppose GE control. Males indicated a higher likelihood than females of taking each of the suggested actions in support of a GE control, and females indicated a higher likelihood of signing a petition opposing a GE control.

Membership of an environmental organisation was associated with increased likelihood of taking action, especially in opposition to GE control.

In relation to a fertility control for possums that **did not involve GE**, 59% of the respondents indicated they would be likely to take some action supporting its use, while only 18% indicated they would oppose its use (Table 11).

In **support** of a **non-GE** possum control, 48% of respondents overall said they would be likely to sign a petition, 46% would be likely to try to convince other people, 26% would be likely to attend a meeting, and 17% would be likely to write a submission.

Potential active **opposition** to a **non-GE** possum control was relatively low, with 18% indicating such action. Eleven percent indicated they would be likely to attend a meeting opposing a non-GE control, 7% would be likely to sign a petition, 6% would try to convince others to oppose it, and 4% would make a written submission.

Table 11. Likely action over a possum fertility control that did not involve genetic engineering

	% of respondents					
	1 Not at all likely	2	3	4	5 Very likely	Don't know
Actions in support of a non-GE control						
try to convince people you know	20	11	22	22	24	1
sign a petition	23	9	19	21	27	2
attend a meeting	42	11	20	14	12	1
make a written submission	55	10	16	8	9	2
Actions in opposition to a non-GE control						
try to convince people you know	69	14	11	2	4	1
sign a petition	69	13	9	2	5	2
attend a meeting	65	11	12	6	5	1
make a written submission	76	10	8	2	2	1

Compared with a GE-based fertility control for possums, there were fewer differences between the respondents in terms of their declared likelihood of acting for and against a non-GE based control. However, rural residents had a higher likelihood than urban residents of attending meetings to support a non-GE control, and members of environmental organisations were more likely than non-members to take each of the suggested actions in support of a proposed non-GE control (Mann-Whitney *U* tests, $P < 0.01$).

Extent of likely action

The extent of a respondent's likely action in support of or opposition to the two forms of fertility control was arrived at by summing, for each of the four options, the number of actions likely to be taken. Those taking action to oppose a GE control were the most potentially active, followed by those acting to support GE control, and those acting to support GE control (Table 12). As with past

involvement in similar issues, a likely "activist" (i.e., someone who would be likely to become involved in trying to influence decisions over a possum fertility control) was defined according to the types of involvement. Here, someone who indicated "4" or "5" to both the likelihood of trying to convince others and signing a petition or who indicated "4" or "5" for their likelihood of attending a meeting or writing a submission was taken to be a likely "activist". The percentage of likely activists for each type of action is noted on Table 12.

Table 12. Extent of likely action over fertility controls

actions to . . .	% of respondents taking any action (to convince, sign, attend, or submit)	Average number of actions per person taking any action	% defined as "activists" among all respondents
support GE control	56	2.1	39
oppose GE control	32	2.8	24
support non-GE control	59	2.3	47
oppose non-GE control	18	1.5	14
support or oppose GE or non-GE control (i.e., any of the above)	79	4.2	63

Categories of actors

Using the "activist" criterion, we categorised the respondents according to their potential behaviour. It should be noted that because stated intentions do not necessarily result in behaviour, these categories can be considered more to represent respondents' attitudes to GE fertility controls than their actual future behaviour.

Just under a third (29%) are likely to be activist supporters of a GE fertility control for possums, and would not be likely to oppose it (Table 13). A further 38% are unlikely to get actively involved (in favour or opposition) over a proposed GE control. The total of these two categories, 67%, is similar to the percentages of respondents finding such a control acceptable in response to our other questions. Only 14% would be activists in opposition to a GE fertility control for possums. Half of these would be activist supporters of a non-GE control; the other half did not indicate that they were likely to actively support a non-GE control and can probably be taken as being against GE control. Ten percent would support a non-GE control, but would not take action against GE. A further 9% said they might take action either in favour or against, depending on the control. These percentages corroborate the results of the questions on attitudes to fertility controls and the use of GE.

The classification of the respondents in Table 13 does not take detailed account of their potential actions in opposition to a non-GE fertility control except where they indicated active opposition to fertility control in both forms. Respondents who indicated active opposition to a non-GE control included those who would oppose both forms of fertility control ("anti-fertility control" as above), those who would only oppose non-GE control along with those who would also support a GE control (together representing 1% of respondents), and a fifth of those who were considered "uncommitted but active".

The activists and non-activists were compared for their perception of the possum problem and its seriousness as a possible reason for their activism. Compared with the non-activists, the potential "activists" were more likely to agree that "possums are a problem in New Zealand and that new forms

of control are required" (Mann-Whitney U test, $P < 0.0001$). In addition, the activists tended to think of the various kinds of possum damage, including overall damage, as more serious than the non-activists (Mann-Whitney U test: $P < 0.001$ for all kinds of damage except to gardens, for which $P < 0.01$). There were significant differences between activist categories in their perception of the overall seriousness of possum damage to New Zealand (Kruskal-Wallis one-way ANOVA, $P < 0.0001$), but multiple comparisons showed that the difference was between the "pro-fertility control" activists and the "all others" group ($P < 0.01$).

Based on the categories of likely activism, it would seem that the level of involvement in decision making over possum fertility control may depend on the extent to which members of the public perceived some feature of a proposed control (e.g., the use of a GE organism) which they objected to or strongly supported, or if a choice of type of control was available (e.g., a non-GE control or a GE-based control). In theory, if both forms of control were offered all of the "likely activists" (63% of the respondents) could become actively involved, whereas if only a GE-based control was proposed 53% could be come involved (at least half of them in support). If a non-GE control only was proposed 50% could become involved (at least three-quarters of them in support).

Table 13. Categories of likely response to a GE fertility control for possums (n=1002)

Activist Category	% of respondents
GE supporters:	
• Pro-GE — likely to support GE control only	7
• Pro-fertility control — likely to support both GE and non-GE control	22
Prefer non-GE:	
but not likely to oppose GE	10
Uncommitted but active:	
likely to either support or oppose GE control, depending on the control	9
GE opponents:	
• Anti-GE — likely to oppose GE control & not likely to support non-GE control	4
• Pro control but Anti-GE — likely to oppose GE control and to support non-GE control	7
Anti-fertility control:	
likely to oppose GE control and non-GE control	3
All others:	
unlikely to take any action to support or oppose a GE control or support non-GE control	38
Total	100

Characteristics of activists

Rural residents were significantly more likely than urban residents to be activists, and to support or oppose GE and non-GE control (Mann-Whitney U tests, $P < 0.005$). Members of environmental groups were more likely than non-members to be activists, and to oppose GE and support non-GE

control (Mann-Whitney U tests, $P < 0.001$). Those who had previously studied genetics were also more likely to be activists, and to support both GE and non-GE forms of control (Mann-Whitney U tests, $P < 0.01$). Males were more likely to be active in supporting GE-control (Mann-Whitney U, $P < 0.001$).

Comparison of past and potential activism

Because stated intention to act does not necessarily result in behaviour, it is improbable that the large proportions of the public noted above would become actively involved in attempting to influence decision making over a proposed fertility control for possums. However, past behaviour in similar situations, indicated here by previous activism in regard to environmental or animal welfare issues, may provide some hint of future involvement. Based on our criteria for past and likely "activism", 60% of the past activists (i.e., 38% of the sample) could potentially become involved in the possum fertility control issue (as likely future activists), compared with 40% of those who had not been past activists. The greater stated likelihood of past activists in becoming active over possum fertility control is statistically significant (Mann-Whitney U test: $P < 0.001$).

Past activists (environmental or animal welfare) were significantly more likely than past non-activists to say they would become future activists in supporting or opposing either form of possum fertility control (Mann-Whitney U test, $P < 0.01$ for all four types of action). The one exception to this pattern is that past animal welfare activists were no more or less likely to say they would become involved in supporting a GE control than the non-activists. The greatest difference between the past activists and the past non-activists lies in their likelihood of **opposing** a fertility control that involved the use of GE.

11. Social Influences on Potential Actions

Previous sections discussed the respondents' intended behaviours concerning the possible use of a fertility control for possums. However, Ajzen & Fishbein (1980) note that the values of others have an influence on a person's intentions and behaviour. More precisely, the influence on intended behaviour comes through the person's perceptions of what people who are important to them might want them to do. The extent of such influence is moderated by the degree to which a person feels motivated to comply with what these "significant other" persons might think. This perceived social influence on behaviour is referred to by Ajzen & Fishbein as the "subjective norm".

In the survey, respondents were asked a series of questions to assess the perceived social influence on their intended behaviour concerning fertility control of possums, the use of GE in the laboratory to produce substances for controlling fertility, and the release into the environment of live GE organisms to control possum fertility. Respondents were asked to rate on a 5-point scale the extent to which they agreed or disagreed with three statements. These were complemented by a question assessing the extent of their likely compliance with this influence.

Twenty-four percent of the respondents felt some possible social pressure from people who are important to them to object to the fertility control of possums (i.e., gave a rating of 4 or 5), 32% perceived possible pressure to object to the use of GE in the laboratory, and 43% perceived possible pressure to object to the release of live GE organisms (Table 14). However, only 20% reported that they tended to comply with such social pressure. Respondents who disagree with a statement that they try to comply with such norms do not necessarily mean that they actively try to go against the perceived norms, rather they do not actively comply with them.

Females reported significantly greater pressure to object to the use of GE in the laboratory and the field release of a GE organism than did males (Mann-Whitney U, $P < 0.001$ and 0.01 respectively). Other demographic factors were not associated with significant differences in perceived influence.

Table 14. Perceived social influence on intended behaviour regarding possum fertility controls

	% of respondents					
Most people who are important to me would think that I should . . .	1 Strongly disagree	2	3	4	5 Strongly agree	Don't know
object to the fertility control of possums.	35	18	18	10	14	5
object to the use of genetic engineering in the **laboratory** to produce substances for controlling possum fertility.	23	18	22	14	18	5
object to the release into the environment of a **live** genetically engineered organism for controlling possum fertility.	18	15	19	19	24	5
Generally speaking, I try to do what people who are important to me **think** I should do.	40	21	18	10	10	1

To understand the potential social influence further, we examined the likely actions of the respondents in the light of the social pressures they perceived. Among those who perceived some social pressure to **object** to the fertility control of possums (i.e., gave a rating of 4 or 5), half indicated they would actually act to **support** such a control, another third would do nothing, and only 4% (or 1% overall) said they would be likely to object to both a GE-based and a non-GE control. Less than half of this latter group reported they generally complied with what others thought they should do.

Similarly, of those who perceived some social pressure to object to the use of GE in the laboratory, a third (or 11% overall) fell into the "Anti-GE" and "uncommitted but active" categories for activism. Of these, a fifth (or 2% overall) were people who said they tended to comply with such social pressure. A quarter of those who perceived social pressure to object to GE in the laboratory would do the contrary, that is, support a GE-based fertility control, while another third would do nothing.

When it comes to the field release of a GE organism for controlling possum fertility, where there is a greater perceived social pressure to object, of those who perceived some pressure to object, 29% (or 13% overall) said they would be likely to take action to oppose a GE-based fertility control, and of these a quarter (3% overall) were people who said they generally tended to comply with what others would have them do. A quarter of those who perceived some possible social pressure to object to field release of a GE organism said they would be likely to actively support a GE-based control, just under a third said they would do nothing.

However, stated intentions to object appear, for some, to be reinforced by the perceived social norm. Of those categorised as "activists" in opposition to the use of a GE-based fertility control for possums, two-thirds also perceived social pressure to object to the use of GE in the laboratory to produce substances for controlling possum fertility, and three-quarters perceived social pressure to object to the release into the environment of a live GE organism. The stated intended behaviour of the activist opponents was thus aligned with the norms of their social group. Over all the respondents, though, perceived normative pressure was not strongly related to stated intended behaviour.

12. Segmentation of Respondents

By classifying respondents according to their reasons for their position on the release of the possum fertility control package (that involved interfering with fertilisation, delivered through a GE plant bait), we were able to produce a segmentation of the respondents. The segmentation was produced by classifying the reasons (guided by principal components analysis), cross-tabulating them, and attempting manually to derive segments that were as mutually exclusive as possible. This was supplemented by cluster analysis of respondents based on the classified reasons, and inspection of the responses of individual outlier cases. In approximate order of increasing concern about the particular fertility control technologies, the segments are: Supporters (27% of the respondents), Accepters (12%), Concerned Accepters (19%), Specificity Concerned (16%), Worriers (9%), Rejectors (7%), and GE Concerned (10%).

The Supporters gave strong reasons why they thought the possum fertility control should be introduced. They thought that New Zealand needed to get rid of possums, that possums caused damage to New Zealand, and that current methods of possum control were insufficient to deal with the problem. The Supporters expressed few of the concerns held by the other segments. (Whilst some members of other segments did give reasons why they though the possum fertility control should be introduced, those reasons were outweighed by their concerns about such an introduction.)

The Accepters also gave reasons why they thought the possum fertility control should be released, but their reasons were less emphatic than those of the Supporters. They indicated that the fertility control sounded good, or sounded humane, or that it was a necessary evil but, unlike the Supporters, did not say that possums needed to be controlled. They reported very few concerns about the particular fertility control.

Both the Supporters and the Accepters, together comprising 39% of the respondents, were straightforward and unequivocal in their support for the possum fertility control, even if it involved the use of GE.

Few of the Concerned Accepters gave reasons why a possum fertility control was needed. Instead, this segment had a range of practical and ecological concerns about the particular fertility control. The practical concerns were mainly that it needed to be well tested and acceptable to scientists, and well managed and regulated. There were also concerns that it would be only a short-term solution and may have negative social or economic impacts.

For the Specificity Concerned, the specificity of the control was the primary issue. This included both current specificity (affecting other animals) and future specificity (through mutation or some other change in host range), as well as the specificity of the plant-based bait used to deliver the fertility control.

Both the Concerned Accepters and the Specificity Concerned, together comprising 35% of the respondents, were generally in favour of a possum fertility control that involved GE. In each of the two segments, 56% considered it to be at least generally acceptable, with another 15% of the Concerned Accepters and 17% of the Specificity Concerned, ambivalent.

The other segments did not support the introduction of the possum fertility control. Most of the Worriers had safety concerns that they were unable to detail. They tended to be worried about possible unforseen effects (without expressing what those effects might be), wanted the certainty of a 100% guarantee that the fertility control was safe before they would accept it, expressed a lack of trust in science or scientists, or expressed some other unspecified safety concern. This contrasts with the

Specificity Concerned, who were explicit in their concern about specificity. Other Worriers said that more research or public information was needed, often without specifying the research they thought was needed. Some Worriers simply expressed unease or discomfort about the whole thing.

The Rejectors felt that a possum fertility control was not needed, because current methods of possum control were enough, or because current methods were better (for example, because they provided employment). Many Rejectors raised ethical objections to the example fertility control, saying that it was "meddling with nature", it was inhumane or cruel, or that possums had rights.

The GE Concerned all raised concerns about the use of GE. Many of these concerns were unspecified, but some were that it may cause unforeseen effects, and that not enough was known about it.

Both the Rejectors and the GE Concerned were against the use of a possum fertility control that involved GE, with three-quarters of each segment finding it unacceptable. The Worriers were more widely spread in their position, with some of them finding such a control generally acceptable, some ambivalent, and others finding it unacceptable.

There was a significant gender difference between the segments. The Supporters, Accepters, and Concerned Accepters were predominantly (55%) male, while the other segments were predominantly (58%) female (χ^2 test, $P < 0.0001$). There were no other clear differences in demographics between the segments, although the Supporters contained a much higher proportion of workers in the primary production industries of agriculture, forestry, and fishing than the other segments.

The segments varied in their acceptance of the various possum control methods (Figure 4). All segments found the fertility controls to be substantially more acceptable than the current methods, with the Accepters seeing the greatest acceptability difference between the fertility controls and the current methods, and the Rejectors the least difference. The Supporters and the Accepters were the most accepting of the two fertility controls, and the Rejectors the least accepting. The Rejectors and the Specificity Concerned were the least accepting of trapping and poisoning. The GE concerned, while not highly accepting of most methods, were second only to the Supporters in their level of acceptance of trapping.

The segments varied more in their acceptance of the fertility control delivery methods than they did for the control methods (Figure 5). The differences between segments for each of the delivery method were highly significant (Kruskal-Wallis one-way ANOVAs, $P < 0.0001$). Multiple comparisons within the Kruskal-Wallis test showed that, for each delivery method, the Supporters were significantly more accepting than all other segments except the Accepters, and the GE Concerned were significantly less accepting than all other segments except the Rejectors (and, for the parasite worm and the virus, the Worriers).

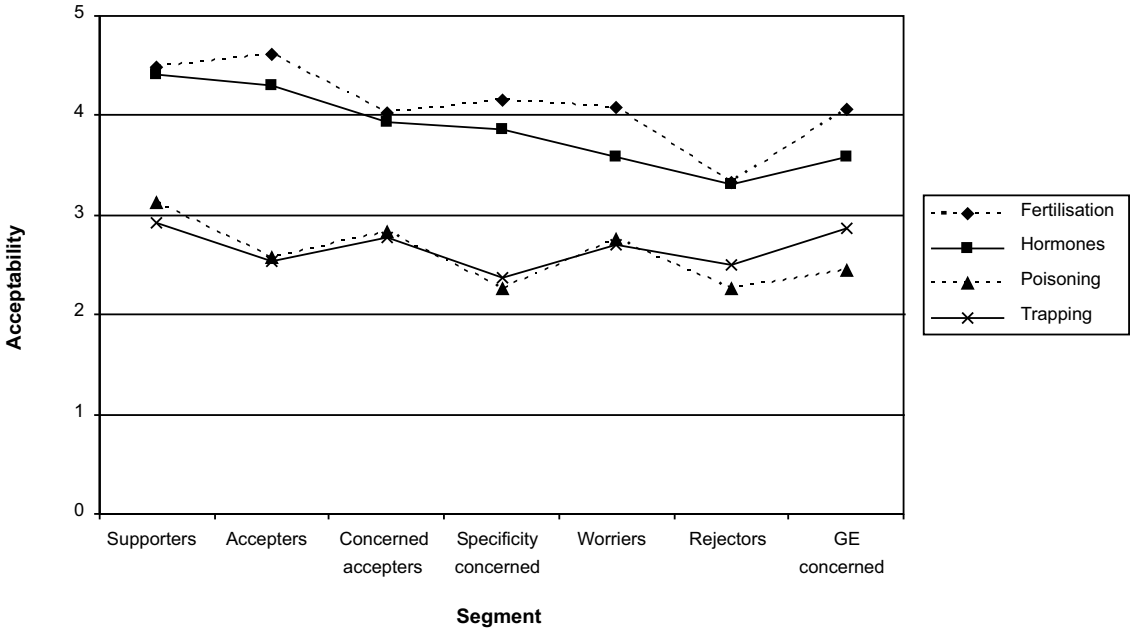

Figure 4. Acceptability of possum control methods by segment (scale: 1 "very unacceptable", 5 "very acceptable")

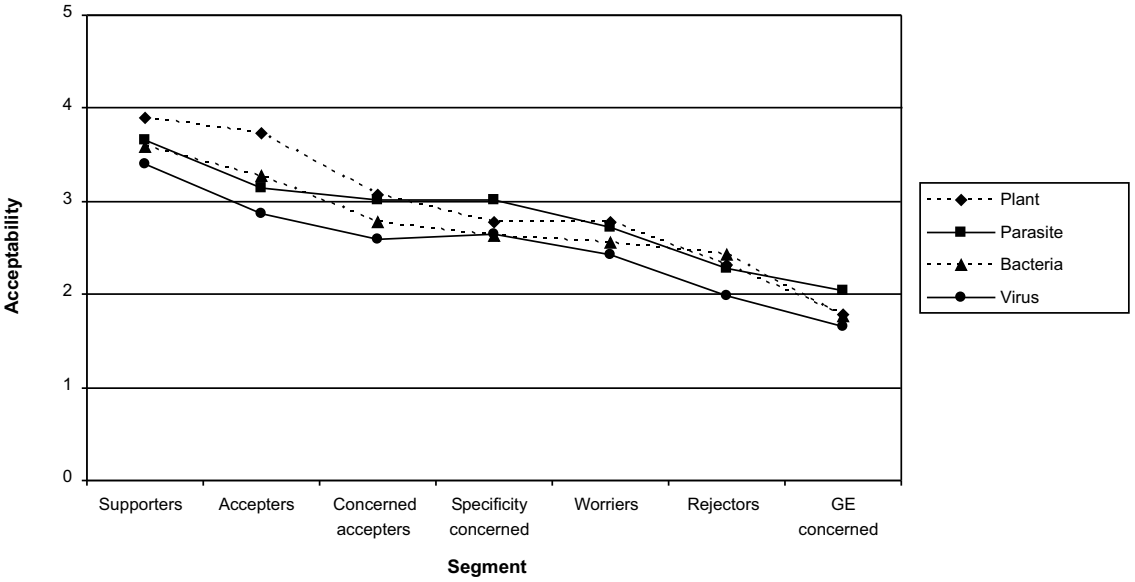

Figure 5. Acceptability of possum control delivery methods by segment (scale: 1 "very unacceptable", 5 "very acceptable")

The segments were compared for their responses to the control method and delivery method components of a fertility control. This was done by adding the mean acceptability of the two components of the example fertility control package (interfering with fertilisation and the GE plant), resulting in a scale from 2 to 10. The segments were more obviously different from each other over

their acceptance of the delivery methods than the control methods (Figure 6). Given that the segmentation was done solely on the basis of reasons for their position on the introduction of an example fertility control package, this confirms our earlier observation about the acceptability of the example fertility control package, that people were responding more to the delivery methods (and possibly their uses of GE) than to the control methods. Since all the delivery methods involved GE, we cannot tell the extent to which GE was an issue in people's reasoning. However, as noted in Table 8, only 12% indicated a concern about GE.

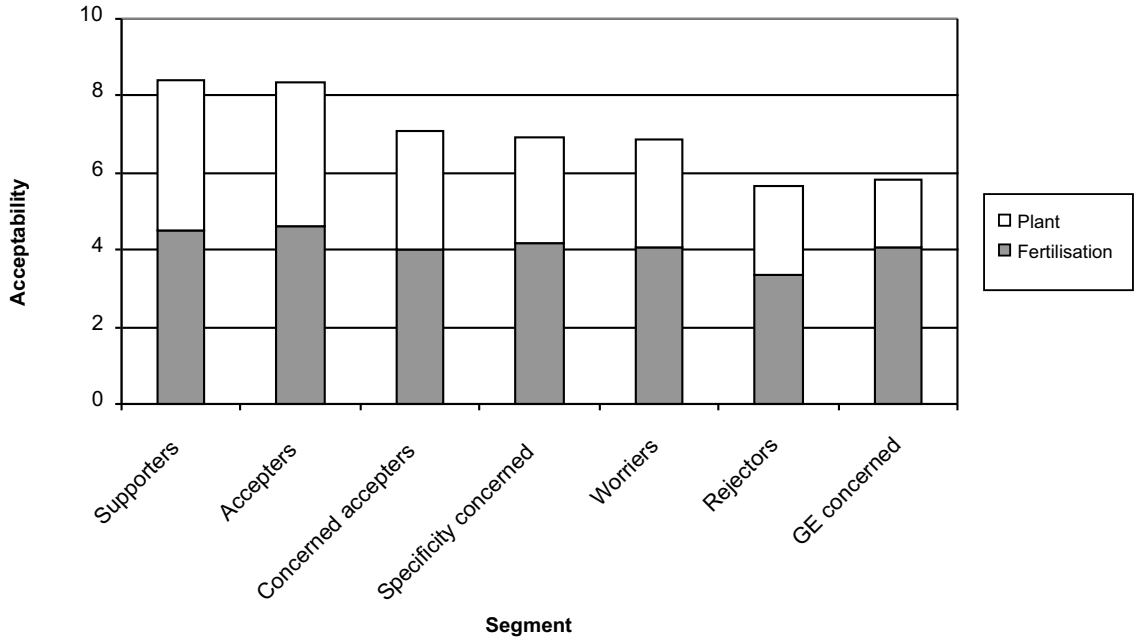

Figure 6. Average acceptability of interfering with fertilisation plus average acceptability of delivery using a GE plant, by segment

The segments differed significantly in their perceived social pressure to object to the use of GE in the laboratory and the field release of a GE organism (Kruskal-Wallis one-way ANOVAs, $P < 0.0001$ in each case). Multiple comparisons showed that the GE Concerned perceived significantly greater pressure to object to both uses of GE than did the Supporters, Concerned Accepters, and Accepters (and also Worriers in the case of the use of GE in the laboratory).

13. Discussion and Conclusion

In recent times, the development of new possum control methods has focused on biological control, in particular fertility controls. The adoption of this direction for possum control research was influenced by the outcomes of our 1994 research, which found that fertility control was widely acceptable to the New Zealand public. As the biological studies have progressed, a variety of possible methods and agents for achieving reduced fertility among possums, and for delivering the control agents to the possum population, have been identified. In the current research, these possible methods, and the means of delivering the control, have been subjected to assessment of their public acceptability and perceived key features. The work is important since public acceptability and perceptions are central to decisions about which methods to invest research funds in, and to identify the potential problems that would need to be addressed in the course of developing the fertility control.

People's perception of the possum problem strongly influences their views on the development of fertility controls. The vast majority of the public continue to see possums as a major problem for New Zealand requiring the development of additional control methods. As in 1994, the public's principal concern is the impact of possums on the environment, rather than the impact on agricultural production and trade. Fertility control, one possible new approach to possum control, was endorsed by the public in our 1994 survey, and the current research confirmed that, for the majority of the public, it remains an acceptable method (by either interfering with fertilisation or interfering with breeding hormones).

Both the focus-group and survey research carried out in this study examined reactions to various forms of fertility control. In most of the focus groups, a fertility control that did not involve GE (for example, interfering with breeding hormones) was evaluated the most favourably of all the possum control methods, though this evaluation was done without consideration of the use of a GE organism to deliver the control. The message from the focus groups was that field release of GE organisms was, at present, unacceptable because the risks were seen as too great and not enough was known about GE and its potential impacts. Use of GE in the laboratory was more acceptable and perhaps necessary so that sufficient knowledge of GE organisms could be acquired, which could help inform decisions about later field releases. GE-based possum fertility control research in the laboratory would, however, necessitate imposing and following strict rules and procedures to avoid the accidental release of experimental organisms.

The survey results confirmed that the current main methods of possum control (leg-hold trapping and 1080 poisoning) are unacceptable to the public, essentially because they are seen as inhumane and not specific enough to possums. Trapping is also considered ineffective at dealing with the possum problem. Moreover, current controls are becoming increasingly unviable from the public's point of view.

In contrast, fertility controls are seen as potentially superior in their specificity, humaneness, and effectiveness. However, when it comes to the reality of having to deliver a fertility control, the public is considerably less accepting and comfortable, especially over the specificity of the GE delivery organism.

Our previous research showed that people are not happy with the release of biocontrol organisms introduced from outside New Zealand, whether or not they are genetically engineered. Such organisms were seen by the focus groups as presenting further danger to an environment already burdened by the effects of introduced organisms. In the current survey, where an unmodified vector organism was described as "found only in possums", it was perceived as being more specific to possums, but not necessarily more acceptable. Use of live or dead GE organisms for delivering a

biocontrol is, on its own, considered unacceptable. However, when packaged with a highly acceptable form of fertility control such as interfering with fertilisation, the resulting package is acceptable to more than half of the public. At present, public acceptance of a fertility control for possums can only really be relied on if its delivery does not involve the release of a live GE organism.

Actual acceptability will depend on the "contents" of a fertility control "package", especially the delivery method. A fertility control package that involved the use of dead GE plant material to deliver a control that interferes with fertilisation would be acceptable to just under two-thirds (64%) of the public, providing their concerns (mainly over specificity, ecological effects, and practical matters such as regulatory safeguards) were addressed. The support by the public would be essentially derived from the acceptability of the fertility control method.

The vast majority (72%) of the public have heard of GE and have some knowledge of it. Our survey protocol ensured that whenever people were asked to comment about GE aspects of fertility control, they were given background explanation. Although level of knowledge of GE is associated with acceptance of possum fertility control, this association does not hold for the acceptability of using GE organisms or products to manufacture or deliver a possum fertility control. Attempts to increase public knowledge about GE will not necessarily increase public acceptance of GE.

Acceptability of control and delivery methods is related to gender, with males tending to find the various technologies more acceptable. "Psychographic" characteristics (represented by our "segments"), which describe belief structures about the issues, were found to be as important as demographic characteristics in discriminating between people's viewpoints. Likewise, the behavioural component of attitude, represented by intention to take action over particular fertility controls, also proved useful in discriminating between people's viewpoints.

A key question for those considering the development of any of the forms of fertility control for possums and delivery methods investigated here is what, if anything, might the public do when faced with a particular proposal to undertake fertility control? The level of public involvement in decision making over possum fertility control could depend on the extent to which members of the public perceived some feature of a proposed control (e.g., the use of a live GE organism) which they objected to or strongly supported, or if a choice of type of control was available (e.g., a non-GE control or a GE-based control). A fertility control that did not involve GE might receive a greater level of overt public support than a GE-based control. A third of the public might publicly object to a control that involved the use of GE, and these people would be particularly active in expressing their views. Those who have had a previous history of action over environmental or animal welfare issues are likely to be the most active in supporting or opposing a fertility control for possums. Of all those who could potentially take some action, those objecting to the use of GE in fertility control are the most strongly reinforced in their views by their social peers, and therefore highly likely to become publicly active in decision making. Because objectors to GE, although outnumbered by supporters, have a "louder voice", submissions and public meetings are unlikely to reflect the public view.

If it is intended to build public support for fertility control of possums, the effort will need to be directed at all sections of the population. Researchers and decision makers need to be aware that women are clearly less in favour of GE-based control than men, with their concerns centring on specificity, humaneness, and other ethical issues. Consequently, females are more likely to take action to oppose a GE-based control, but would possibly support a non-GE control.

While our results broadly indicate that GE is acceptable to a degree, the use of GE remains contentious and public opinion about it is divided. If researchers are to continue to explore GE controls, the most publicly acceptable strategy would be to concentrate on controls that did not involve the field release of live GE organisms and did not involve microorganisms. The GE plant

meets these two criteria. The most acceptable strategy, however, would be to concentrate on non-GE delivery methods.

14. Acknowledgements

This questionnaire was more difficult for the interviewers to administer and the respondents to answer than any other we have produced. We are grateful to the interviewers for their professional approach and to the respondents for their forbearance. Particular thanks to Nic Fitzgerald for his assistance in managing the team of interviewers and for his careful coding and data entry work. Andrew Wallace provided helpful statistical advice. Funds for this research were provided by Landcare Research from its own resources. We thank Landcare Research, and Ian Whitehouse in particular, for their ongoing recognition of the importance of research to understand the social environment of pest management decision-making, and for their commitment to funding such social research.

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16. Appendices

Appendix 1 Focus group topics

1. Introduce team. Purpose of study. Non-partisan nature of study.
   Purpose, role, and non-partisan nature of PCE.
   Purpose of focus group. Round robin of brief statement of any personal involvement with possums or possum control.

2. Reminder briefing on the "possum problem" in general terms, as per text and overheads.
   What do you think NZ should be doing about possums?
   Should NZ be doing anything?

3. Reminder briefing on current controls and control options, including biocontrols, as per text.
   How do you feel about the particular forms of possum control we have outlined?
   Current control methods?
   Biological control generally?
   Fertility control?

4. Reminder briefing on fertility control options, as per text.
   [Questions about technical issues only. Note any more general or issue-based questions to return to later.]

5. How do you feel about the particular forms of fertility control? *Why?*
   [Allow issue-based questions during discussion. Reflect questions back to questioner to get them to clarify the issue.]

   How do you feel about the use of genetic engineering to come up with a fertility control method? *Why?*
   Trade-offs and "veto issues"?

   How do you feel about fertility control compared with other forms of biological control that we have outlined? List methods. *Why?*

6. What do you think are the important questions that need to be considered when deciding whether to **research and develop** a genetically engineered fertility control for possums?
   Should we develop it?
   Under what conditions should we develop it?

   So, if a genetically engineered fertility control for possums is developed, what do you think are the important questions that need to be considered when deciding whether to **actually use** it?
   Should we use it?
   Under what conditions should we use it?

7. How should these decisions be made?
   Who should make the decisions?
   Checks and balances?
   Credibility of players?
   How do you feel about science and scientists in general?

8. How did you feel about the material we provided?

9. Given our discussion so far, and the information we have given you, what further information do you need to have to decide for yourself whether NZ should be developing and using these fertility control technologies?
   Who from? Why them?
   How?

10. Wind-up.

Appendix 2 Questionnaire

Case No. [ ]

Questionnaire on possum fertility control

(5 March, 2001)

[Fill in after interview completed]

Phone number: ( ) ..... Phoning area .....

Date ..... / ..... Time ..... am / pm Interviewer initials .....

Hello, my name is *[first name & surname]*. I'm calling on behalf of Landcare Research, the Crown Research Institute. We are conducting a survey of people's views on genetic engineering and the control of possums in New Zealand. **This is not a market research survey, and we are not trying to sell you anything**. But, everyone who does the survey will go into a draw for an Air New Zealand mystery weekend for two. The person who lives in your household I would like to interview is the one who most recently had their birthday and is aged 18 or over. Is that person at home now?

[If no:] When can I call back? *and:* And who should I ask for? *[Record details on phone list sheet]*

[If a new person:] My name is *[first name & surname]*. I'm calling on behalf of Landcare Research, the Crown Research Institute. We are conducting a survey of people's views on genetic engineering and the control of possums in New Zealand. **This is not a market research survey, and we are not trying to sell you anything**. But, everyone who does the survey will go into a draw for an Air New Zealand mystery weekend for two.

[To all:] Your responses will be treated anonymously and absolutely confidentially. Would you be willing to go through the questionnaire? It should take about 20 minutes.

[If willing but not now, ask:] When can I call you back? *and:* And who should I ask for?
[Record details on phone list sheet]

1. Which one of the following statements best describes your view of possums in New Zealand?

[1 =] Possums are **not a problem** in New Zealand *[1–3, DK = 9]*
[2 =] Possums **are** a problem in New Zealand and current methods of control are **adequate**
[3 =] Possums **are** a problem in New Zealand and **new** forms of control are required [ ]

[Current methods adequate if enough money spent = 2]

2. How great a problem for New Zealand do you think the following types of possum damage are? Use a scale where 1 means "**no** problem" and 5 means "a **major** problem".

[1 – 5, DK = 9]

Possum damage to New Zealand's native bush and native birds	
The damage caused to New Zealand's overseas agricultural trade by possums infecting cattle and deer with Bovine tuberculosis	
Possum damage to people's gardens	
Overall, how great a problem do you think is the damage caused to New Zealand by possums?	

3. I am now going to ask you what you think of four methods for controlling possum numbers: trapping, poisoning, and two methods of controlling possum fertility that are being researched at the moment. Some of the questions might be difficult for you to answer. Please try your best but, if you really couldn't say, please tell me.

[1 – 5, DK = 9]

[Work across] The first method is . . .	How XXXX do you think this method of controlling possums would be? Use a scale where 1 means "**not at all**" and 5 means "**very much**".			On a scale where 1 means "very **un**acceptable" and 5 means "very **acceptable**", how **acceptable** do you **think** this method of controlling possums would be **to you**?	On a scale where 1 means "very **un**comfortable" and 5 means "very **comfortable**", how **comfortable** do you **feel** about this method?
	humane *[not cause possums to suffer]*	**specific** to possums *[not affecting any species other than possums]*	**effective** in reducing possum numbers		
Trapping. The possum is attracted by a lure and caught in a smooth jawed leg trap. It is then killed within 24 hours *[e.g. by a blow to the head]*.					
The next method is . . . **Poisoning** using 1080 poison. The possum eats a fatal dose of the poison and dies from heart or lung failure within 12 hours.					
The third method is . . . **Interfering with fertilisation**. The possum eats a bait containing a protein from possum eggs. This causes the female possum to develop an immunity to its own eggs and react against them as if they were foreign to it. It fails to become pregnant.					
The last method is . . . **Interfering with breeding hormones**. The possum eats a bait containing a drug that kills the particular cells that control the production of breeding hormones in one part of the brain *[i.e. the pituitary gland]*. This causes the possum to have a low sex drive, and become less fertile.					

4. Which one of the following best describes the **extent** to which you have **heard of** genetic engineering?

[5 =] I have studied it and have a good **understanding** of its technicalities
[4 =] I have heard about it and could probably **explain** it to a friend *[1 – 5, DK = 9]*
[3 =] I have heard of it and know **something** about it
[2 =] I have heard of it but know **little or nothing** about it
[1 =] I have **not** heard of it

5. The possum fertility controls being researched need a way of **producing** the control substance and getting it **into** the possum. This **may** make use of genetic engineering. Genetic engineering could be used in **two** possible ways.

Firstly, an organism such as a plant or bacteria could be genetically engineered to produce a possum fertility control substance. The organism is then **killed** so it cannot reproduce when released into the environment.

Secondly, genetic engineering could be used to modify an **existing** organism so that it **carries** the fertility control substance. The organism is then released **alive** into the environment to spread from possum to possum.

I am now going to ask you what you think of four methods of **producing** the fertility control substance and getting it **into** the possum. These methods are still being researched.

[1 – 5, DK = 9]

[Work across] The first method is . . .	How XXXX do you think this method would be? *[i.e. method of getting the fertility control substance into the possum]* Use a scale where 1 means "not at all" and 5 means "very much".		On a scale where 1 means "very **un**acceptable" and 5 means "very **acceptable**", how **acceptable** do you **think** this method would be **to you**? *[i.e. method of getting the fertility control substance into the possum]*	On a scale where 1 means "very **un**comfortable" and 5 means "very **comfortable**", how **comfortable** do you **feel** about this method?
	specific to possums *[i.e. not getting into any species other than possums]*	**effective** in getting the substance into the possum		
A **plant** is genetically engineered so that it contains the substance that affects possum breeding. Then the plant is killed so that it can't grow, and a bait made from it is eaten by possums.				
The next method is . . . A **bacteria** is genetically engineered so that it produces the substance that affects possum breeding. Once it has produced the substance, the bacteria is then killed so that it can't grow. The remains of the bacteria, which contain the substance, are put in a bait, which is eaten by possums.				
The third method is . . . A **parasite worm** that is found **only** in possums is genetically engineered to produce the substance that affects possum breeding. The **live** parasite worm is then released to allow it to spread from possum to possum.				
The last method is . . . A **virus** that is found **only** in possums is genetically engineered to produce the substance that affects possum breeding. The **live** virus is then released to allow it to spread from possum to possum.				

6. How would you respond to the following statements? Use a scale where 1 means "strongly **dis**agree" and 5 means "strongly **agree**".

[1 – 5, DK = 9]

Most people who are important to me would think that I should **object** to the fertility control of possums.	
Most people who are important to me would think that I should **object** to the use of genetic engineering in the **laboratory** to produce substances for controlling possum fertility. Remember, 1 means "strongly **dis**agree" and 5 means "strongly **agree**".	
Most people who are important to me would think that I should **object** to the release into the environment of a **live** genetically engineered organism for controlling possum fertility.	
Generally speaking, I try to do what people who are important to me **think** I should do.	

7. The next few questions cover your involvement in particular issues. Looking at activities relating to **conservation or the environment**, in the past few years have you ever:

[Yes = 1, No = 2, DK = 9]

Tried to convince people you know to take a **pro**-environment position on some issue	
Signed a pro-environment petition	
Attended a pro-environment meeting	
Made a pro-environment written submission *[includes a "letter to the editor"]*	

Looking at activities relating to **animal welfare**, in the past few years have you ever:

[Yes = 1, No = 2, DK = 9]

Tried to convince people you know to take a position in **favour** of animal welfare	
Signed a petition in favour of animal welfare	
Attended a meeting in favour of animal welfare	
Made a written submission in favour of animal welfare *[includes a "letter to the editor"]*	

8. Scientists are currently trying to develop a possum fertility control that involves genetically engineering a plant so that it contains a protein from possum eggs. The plant would then be killed so that it can't grow, and a bait made from it would be laid for possums to eat. The protein would cause the female possum to develop an immunity to its own eggs and react against them as if they were foreign to it. It would fail to become pregnant.

If such a possum control were to be developed, do you think it should be released in New Zealand?

[Yes = 1, No = 2, Depends = 3, DK = 9]

If "yes" or "no", ask: Why?
If "depends", ask: Depends on what?
If "don't know", ask: Can you tell me why you don't know?
[Probe or clarify if necessary.]

9. Thinking about the possible use of a fertility control for possums that **involved genetic engineering**, how likely is it that you would do any of the following? Use a scale where 1 means "**not at all** likely" and 5 means "**very** likely".

[1 – 5, DK = 9]

Try to convince people you know to **oppose** such a use	
Try to convince people you know to **support** such a use	
Sign a petition opposing such a use	
Sign a petition supporting such a use	
Attend a meeting to **learn about** such a use	
Attend a meeting about opposing such a use	
Attend a meeting about supporting such a use	
Make a written submission opposing such a use *[includes a "letter to the editor"]*	
Make a written submission supporting such a use *[includes a "letter to the editor"]*	

Thinking now about the possible use of a fertility control for possums that **did not involve genetic engineering**, how likely is it that you would do any of the following? Use the same scale, where 1 means "**not at all** likely" and 5 means "**very** likely".

[1 – 5, DK = 9]

Try to convince people you know to **oppose** such a use	
Try to convince people you know to **support** such a use	
Sign a petition opposing such a use	
Sign a petition supporting such a use	
Attend a meeting to **learn about** such a use	
Attend a meeting about opposing such a use	
Attend a meeting about supporting such a use	
Make a written submission opposing such a use *[includes a "letter to the editor"]*	
Make a written submission supporting such a use *[includes a "letter to the editor"]*	

To finish up, a few questions about yourself.

10. Have you ever . . .
[1 =] Owned or worked on a farm
[2 =] Lived in a rural area

[Neither = 0, Both = 3]
[code 0 – 3, DK = 9]

11. At **present**, are you an urban *[city / town]* or rural resident? *[Urban = 1, Rural = 2, DK = 9]*

12. Are you **currently** a member of . . .

[Yes = 1, No = 2, DK = 9]

An environmental or conservation group or organisation?	
An animal welfare group or organisation?	

13. Which of the following age groups do you belong to:
[1 =] under 20,
[2 =] 20 – 29,
[3 =] 30 – 39, *[1 – 6, Refused = 8, DK = 9]*
[4 =] 40 – 49,
[5 =] 50 – 59,
[6 =] 60 or over

14. From the following list, can you tell me your highest formal educational qualification?
[1 =] No school qualification
[2 =] School Certificate *(5th form)*
[3 =] 6th Form Certificate or University Entrance *[1 – 6, Refused = 8, DK = 9]*
[4 =] Trade certificate or equivalent
[5 =] Professional diploma or other technical qualification
[6 =] University degree

15. Have you ever studied genetics? *[Yes = 1, No = 2, DK = 9]*

16. What is your **usual** occupation: _____ *[enough detail so we can classify respondents]*

17. Could you please tell me who to ask for if you win the draw for the mystery weekend?

_____

Gender: male/female *[1 = male, 2 = female]*

Wind up — express thanks for their cooperation etc.

If respondent wants results, tick box

Time taken: ..... mins

Now fill in the information on the front page.

Appendix 3 Tables

Table A 1. Age profile of the respondents

Age group	Number of respondents	% of respondents	% of NZ population aged 18 and over *
18–19	16	1.6	4.0
20–29	97	9.7	20.7
30–39	234	23.5	22.0
40–49	259	26.0	18.9
50–59	183	18.4	13.1
60 and over	208	20.9	21.2
Total	997	100.1	99.9
Missing	5		

* from 1996 Census of Population and Dwellings

Table A 2. Educational qualifications of the respondents

	Number of respondents	% of respondents	% of NZ population aged 15 and over (2001)
No school qualification	137	13.6	23.7
School Certificate / 5th Form	159	15.9	13.5
6th Form and Higher Certificate	191	19.1	21.0
Vocational qualification or trade	286	27.6	17.6
University degree	223	22.2	10.1
Refused / not specified / other	16	1.6	14.1
Total	1002	100.0	100.0

Table A 3. Perceived properties of possum control methods (n=1002)

Property and method	% of respondents					
	1	2	3	4	5	Don't know
Humaneness	not at all humane				very much humane	
Interfering with fertilisation	5	5	7	20	61	2
Interfering with breeding hormones	5	6	11	23	52	3
Poisoning using 1080 poison	25	24	22	17	10	2
Trapping using smooth- jawed leg-hold trap	37	18	24	10	10	1
Specificity	not at all specific				very much specific	
Interfering with fertilisation	4	5	10	17	47	17
Interfering with breeding hormones	4	6	17	18	36	19
Poisoning using 1080 poison	27	22	22	14	7	8
Trapping using smooth- jawed leg-hold trap	25	25	20	13	11	6
Effectiveness	not at all effective				very much effective	
Interfering with fertilisation	3	4	11	29	39	14
Interfering with breeding hormones	3	8	18	29	28	14
Poisoning using 1080 poison	7	15	31	28	1	6
Trapping using smooth- jawed leg-hold trap	20	37	24	9	5	5

Table A 4. Perceived properties of possum fertility control delivery methods (n=1002)

Property and method	% of respondents					
	1	2	3	4	5	Don't know
Specificity	not at all specific				very much specific	
GE plant (killed, in a bait)	11	15	24	19	13	18
GE parasite worm (live, spread from possum to possum)	10	7	12	23	36	12
GE bacteria (killed, in a bait)	12	16	25	19	10	18
GE virus (live, spread from possum to possum)	13	8	17	21	29	12
Effectiveness	not at all effective				very much effective	
GE plant (killed, in a bait)	7	14	29	23	12	15
GE parasite worm (live, spread from possum to possum)	7	10	19	27	25	12
GE bacteria (killed, in a bait)	7	13	31	23	11	15
GE virus (live, spread from possum to possum)	8	9	18	29	24	12

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