Caught in the Headlights:

New Zealanders' reflections on Possums, Control Options and Genetic Engineering

OFFICE OF THE
PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT
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Preface

Possums invade the lives of many New Zealanders. Possums are not just a problem for New Zealand's forested environments and farmlands. Even in the middle of the capital city, Wellington, they are wreaking havoc. My home is next to the Town Belt, the open-space areas set aside when the city was first established, and now a rich mosaic of native and introduced trees enlivening the central cityscape. But these urban green areas are also home to thousands of possums. My wife Pam and I operate two Timms traps and two bait stations. In two and a half years in our new home, we have trapped over 50 possums. Their buried bodies do good service, returning back to the environment the nutrients they stripped from the Town Belt vegetation, fertilising the new native plants Pam and I have put in on our hillside. Our catches are not exceptional – our neighbours and many other households in the inner suburbs carry out similar levels of possum control, adding to council efforts.

The point of this personal story is that possums are an issue for many New Zealanders, whether city dwellers or country folk, environmental managers, farmers, tangata whenua, or traders taking our exports to the rest of the world. Although many New Zealanders recognise that possums are a major problem, there is an ongoing need to reinforce awareness of the threats possums pose to our environment and our economy. The New Zealand public needs and expects to be involved in questions about possum management, and to have a say about the methods used for dealing with these pests.

This investigation has its origins in the reality that communities and interested groups in society are demanding greater participation in the directions taken in scientific research programmes and the types of technologies being developed. When the research involves a high-profile pest, when the target animal is warm-blooded, soft-furred and large-eyed (if little loved), and when the technologies being developed are intended for widespread release into the natural environment, involvement of the public, tangata whenua and interested groups will be especially critical. If science fails to engage with society, to listen to communities' concerns, and to jointly develop the needed research questions, there may be a high probability that any resultant technologies would be rejected. The expectations for public involvement are only heightened by the introduction of genetic technologies into the possible toolbox of possum control methods.

As the French writer, Eugene Ionesco, has said, "It is not the answer that enlightens, but the question". Gaining insight into New Zealanders' views on possum management futures has been no easy task. There was a need for information on the current biocontrols research, as the basis for running a process of dialogue with communities, tangata whenua and those groups and sectors with a particular interest in possums. Therefore two Crown Research Institutes, Landcare Research and AgResearch, were key partners in this investigation. In addition, our approach to the whole topic was shaped by a Reference Group, an eclectic group of talented individuals from a wide range of backgrounds. Through four full-day workshops and in their other input to the project the Reference Group provided clarity, focus and rigour to the questions that needed to be asked, and helped sharpen the processes for talking with and listening to communities and interested groups. In hindsight the collective learning of the Reference Group discussions was one of the most valuable parts of this study, helping my team and me to scope out and to explore the vast and varied environmental, socio-economic, cultural, metaphysical and ethical dimensions within which New Zealand is trying to deal with possums and develop future controls.

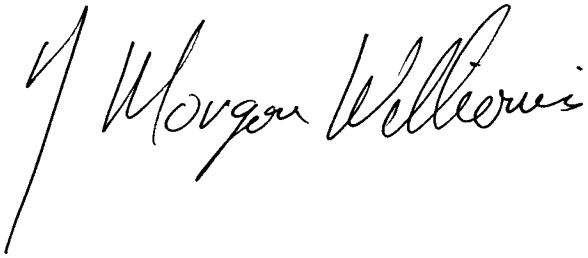
Appreciating the many contexts of possum biocontrols is crucial to understanding what we heard during this investigation, and deciding on where to go next. The intent was to examine New Zealanders' views on possum biocontrols. Because most of the biocontrol methods being researched involve genetic engineering (GE), it was inevitable – and highly desirable – that there was vigorous debate about GE in the wider sense, as distinct from simply the biocontrols. The investigation took place against the backdrop of passionate debates about GE food, labelling regulations, and ongoing global concerns about the safety of high profile GE crops such as Roundup®-Ready corn and canola. This was a real bonus because it ensured possum biocontrol futures were debated within local, national and international contexts.

In terms of public acceptability, the application of GE to possum controls appears to be somewhere in between medical applications and application to food. This study has confirmed that the

intended benefits of a new technology are very significant in people's assessments of acceptable risk. Because there is awareness that current control methods are costly and have their limitations, this investigation was able to focus on some of the critical questions around how, why and whether GE science might contribute to future pest management.

The starkness of the choices was recognised, but so too was the inescapable importance of the larger contexts, which are about much more than just the science of potential control technologies. Participants in this investigation were as concerned (in some cases more so) about questions such as whether New Zealand really wants these kinds of technologies, who is funding the research, who will benefit, what might be the costs, and who will carry any risks. Through all our discussions was a critical subtext question: Who can people trust to tell them the truth about such issues, as well as to explain the science? Therefore this report devotes considerable space to working through the various contexts and the philosophical, cultural and ethical frameworks within which the dialogue about possums occurred.

This study is one small contribution to working out how to reduce the impact of possums on New Zealand's ecology and economy. It highlights the need for much more investment in the sciences of societal engagement. We are no longer in an era when questions about technology and its future uses can be left to a small section of society – the science organisations and their investors, public or private. New Zealanders have considerable wisdom and experience that can help in the process of shaping and asking the right questions. It is essential – for effective possum control across this country's landscapes, for the credibility and public acceptability of science in the 21st century, and for an appropriate response to the challenges of genetic technologies – that we engage with and utilise this wisdom.



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Parliamentary Commissioner for the Environment

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1. INTRODUCTION

1.1 Project Origins – How It Began

Why did the Parliamentary Commissioner for the Environment (PCE) decide to explore public attitudes and understanding about potential possum biocontrols, some of which involve genetic engineering?

There were two main reasons. The first is that New Zealand's recent experiences with proposals to release biological control agents (biocontrols)* have led to polarised debates indicating inadequate processes for all stakeholders to contribute to decision-making. This leads to the second reason, which is that the application of science – rapidly advancing and potentially enormously powerful – to society's needs in the 21st century will require greatly increased levels of dialogue and trust between science and society.

At the core of the investigation are New Zealand's experiences over the last twenty years or more with various biocontrols for the management of exotic pests. There are two fundamental imperatives:

- ensuring the ongoing viability and health of New Zealand's natural biodiversity, and effectively controlling the numerous introduced animal pest and weed species which are the principal threats to that unique indigenous heritage; and
- ensuring the sustainability of New Zealand's production environments, and of the trade and export industries that are the basis of our economy.

A more recent priority is the need for New Zealand to address the question: What is an appropriate and acceptable future role for genetic science and its applications in the environment? This will necessitate assessment of the risks as well as the possible benefits both for primary production and for biodiversity. It will also require recognition and respect for the values, beliefs and concerns raised by New Zealanders in relation to these powerful new technologies.

The application of genetic science to the management of our number one vertebrate pest, the possum, has the potential to reveal much about New Zealanders' perceptions of risks and benefits. While it is clear to most New Zealanders that possums should be controlled or even exterminated, many worry about current control methods such as 1080 poisoning, and acknowledge that the annual costs of possum damage to New Zealand is not sustainable. But the development of biocontrols involving genetic engineering (GE) raises some complex and important questions.

The increasing remoteness of scientific research - from general public understanding and acceptance of that science, its potential applications or uses, and the risks involved – is another important underlying trend with the potential to greatly affect the responses to these questions. Matters of trust, dialogue processes, communication, transparency, decision-making processes, and science literacy are fundamental factors to consider here.

These interrelated issues all arose and were debated during the course of this investigation.

1.1.1 Biocontrols

Through the 1980s and 1990s New Zealand went through two major public debates about proposed rabbit biocontrols. (The principal driver for rabbit control was primary production, rather than the protection of biodiversity.) Firstly there was protracted debate about the possible release of the myxoma virus and its carrier flea; then there was a highly public assessment of an application to release the rabbit calicivirus (RCD**). Both proposals were declined by the assessing agency, the Ministry of Agriculture and Forestry; however, RCD was subsequently unofficially imported and released (see Box 1: The RCD Saga).

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* Biocontrol involves using biological means to control a pest, rather than chemical means (poisoning, repellents) or physical means (trapping, shooting, fences). Biocontrol agents can include predators of the target species, viruses or other organisms that will cause disease, and parasites.

** This disease is also known as RHD or rabbit haemorrhagic disease. However in New Zealand it is most commonly known as RCD, and thus this report will use that name.

Box 1: The RCD Saga

In the 1980s a virus that produced a disease known in Europe as RHD (Rabbit haemorrhagic disease) or in Australia as RCD (Rabbit calicivirus disease) swept through domestic rabbitaries first in China and then throughout Europe. Tens of millions of domestic rabbits were killed before vaccines were developed. In response to reports in 1988 that RCD was killing wild rabbits in Spain, a joint Australian/New Zealand research programme assessed its potential as a biocontrol. The virus was initially tested for species specificity, in quarantine, before field trials were begun on Wardang Island off South Australia. During these trials the virus escaped to the mainland and became widely established in wild populations. The Australian Government made a retrospective decision to systematically release RCD through all rabbit infested areas and to monitor its effectiveness and wildlife impacts.

Following the accidental escape of RCD in Australia, a New Zealand collective of Local Government, Federated Farmers and a Crown Land Agency applied to release RCD in New Zealand. The application, and its assessment by the then Ministry of Agriculture and Fisheries, was one of the most comprehensive and intensively debated in New Zealand's biocontrol history. In July 1997 the application to release RCD was declined by Government. In August 1997 RCD-infected rabbits were found in Central Otago, as the result of what is assumed to have been an illegal importation. Landholders rapidly replicated and spread the virus and it is now well established throughout New Zealand.

The illegal release of RCD was but one act within a very complex socio-economic context that spanned nearly two decades. The context involved central and local government policies, consideration of costs and benefits, risks and hazards, public perceptions of fairness and trustworthiness, and positive signals from scientists and science funders for biocontrols. The biosecurity breach, the illegal importation of RCD, was a major environmental management system failure.

One aspect of this failure was a significant gap in understanding and beliefs between landholders and the New Zealand public, about the nature of the rabbit "problem", and the options available for reducing the pest's impacts. Many non-farming New Zealanders felt that rabbits were not a big enough problem, that there were other solutions and, therefore, the introduction of a new virus was not warranted.

Failures of trust were also important. The applicant groups' assessment of RCD risks was not trusted, as they were potentially the main beneficiaries. Similarly Government was not trusted because it had been the main RCD research funder. A Rabbit Biological Advisory Group (RBAG), consisting of potential supporters and opponents of introduction, produced a compendium of RCD information (pros and cons); but this group was also not widely trusted, perhaps because it was funded by a collective of Government agencies.

What are the lessons from the rabbit biocontrol saga for the future of possum biocontrols? There are three critical aspects:

1. The full socio-economic contexts within which the biocontrol is being developed – who wants it, who benefits, who will carry the risks, etc – must be mapped out;
2. Community perceptions of the pest problem must be determined; and
3. Those who can be trusted to provide all the desired information about the proposed biocontrols must be identified.

If these three aspects are not fully understood, and provided for, any science or sector led effort to develop possum biocontrols (genetically engineered or otherwise) is unlikely to achieve the outcomes currently desired by research investors or those responsible for reducing possum impacts. Societal concerns about viruses shaped the RCD decision, as concerns about genetic modification will continue to shape the future of possum biocontrols. These realities must be fully integrated into possum control research and development (R&D) efforts in New Zealand.

The history of pest control in New Zealand illustrates that it is much more than a technical issue.[1:1] Previous PCE investigations have addressed these issues. In 1994 the PCE produced a major report on possum management in New Zealand, following heightened public concern about risks of 1080 to human and animal health, and about the level of consideration given to alternative methods such as hunting and trapping, particularly where aerial bait drops were being proposed. The PCE's investigation looked not only at community values and concerns but also the processes of local government in informing and consulting with local communities over possum control programmes. (see 1.2.1)

As the debates over myxomatosis and RCD illustrated, pest control is both a public and political issue. A range of factors are involved – the widespread public support for conservation of New Zealand's natural landscapes, extraordinary wildlife and complex ecosystems; the various initiatives developed through the 1990s for sustainable environmental management; the nation's international commitments under the Convention on Biological Diversity and other agreements; and the increasing sensitivity about environmental standards in the overseas markets where New Zealand sells its products. These trends mean that the introduction of potentially powerful new organisms into the environment will be a matter of concern, even if the intent is to protect our unique ecosystems. Some past biological introductions have had disastrous consequences, and this concern lives on.

1.1.2 Genetic science

Many people believe there is potential for New Zealand to benefit from genetic science. However, global experience with the development and application of two other relatively mature science fields, chemistry and physics, has shown that while these areas of science have brought extensive benefits to the world, there can be many unknowns that only emerge after the science and its associated technologies have been in use for some time – for example, issues associated with the use of nuclear power, pesticides, and some pharmaceuticals. (See Box 9: The lessons of nuclear science.) There will inevitably be surprises emerging as the genetic sciences and their applications develop and mature over the next few decades.

New Zealand is a tiny nation very dependent on biological product exports from land and sea, and with enormous responsibilities as the guardian of a unique Gondwanan remnant. Given the magnitude of the potential benefits and risks of genetic technology to New Zealand's biodiversity (both indigenous and valued exotic species) – and the public concern that has already surrounded the development and application of the new genetic technologies both in New Zealand and globally – it will be essential to maintain a close watch on the evolution and use of this recent field of scientific endeavour.

In his August 1999 *News Sheet*, the PCE commented on the growing controversy over genetically modified food and expressed unease at the "ongoing lack of visible leadership at a strategic level". This investigation into public attitudes towards possum biocontrols arose out of the PCE's concerns over a perceived lack of strategic direction for determining an acceptable future role for genetic science in New Zealand, as distinct from the processes managed by the Environmental Risk Management Authority (ERMA) for the consideration of particular applications for new organisms (see 2.6.4.1 and 2.9.5-2.9.7).

The PCE believes that protecting our indigenous ecosystems, and the businesses dependent on New Zealand's natural resources, will require a strategic approach to the risks and opportunities associated with any future uses of genetic science. In order to be effective this approach will need to take into account the range of views, values, and concerns New Zealanders have about science and genetic technologies.

This investigation is an initial step in this direction. By taking a critical look at a very specific slice of the larger genetic technologies question – biocontrol of possums, potentially using genetic engineering – the PCE sought to gain insight into the views and concerns of the public about the wider possible uses of genetic technologies, particularly techniques involving the release of genetically modified organisms (plant or animal), into New Zealand's natural environment. Inevitably, the discussions undertaken in this investigation have touched on many issues of broader interest and concern in regard to genetic engineering and its possible uses, outside the immediate topic of possum biocontrols (see 1.3.1-1.3.3).

The establishment of a Royal Commission on Genetic Modification in May 2000 signified the Government's awareness that a broad-ranging discussion regarding genetic engineering is required. The Royal Commission is to inquire into, and report on, the strategic options that will enable New Zealand to address genetic modification now and in the future. The Royal Commission is required to consult widely and to adopt procedures that encourage a diverse range of people and groups to participate in the proceedings and present their views.[1:2] A voluntary moratorium on all applications for the release of genetically modified organisms will be in place during the Commission inquiry; the moratorium also applies to the field testing of genetically modified organisms (GMOs), with some exceptions. The official commitment to the Royal Commission occurred after the PCE's investigation was under way in mid-1999.

1.1.3 Science and society

Clearly, the public's attitudes and values regarding pests, and pest control technologies, especially those using genetic engineering, should play an important role in policy development and decision-making. Research[1:3] shows that understanding public perceptions and concerns about new pest control technologies, such as biocontrols for possums, will require knowing:

- what is considered safe and unsafe technology;
- what risks people would be willing to tolerate in order to stop possums' damage to New Zealand's native forests and spread of bovine tuberculosis (Tb);
- what is the basis for those judgements and concerns, and what influences them; and
- the types and levels of information people need and want in order to make decisions.

A notable feature of the rabbit biocontrol saga, and also of the growing public anxiety about genetically modified foods, has been the wide differences evident between those researching, developing and promoting the technologies, and the values, perceptions and priorities of New Zealand society. Increasingly citizens in many walks of life want to know more about what science is actually doing, and to have more say in what technologies should, and should not, be developed in the name of bettering their world. This has been acknowledged for over a decade among researchers examining societal attitudes to science and risk. However, at some professional, political, academic and commercial levels, recognition of public concerns, and of public expectations of involvement in determining the directions and uses of science, has to date been very limited.

These gaps or differences in understanding and approach are critical obstacles to resolving a number of questions – for example, the need for these technologies and the nature of the problems they are intended to address; the processes for assessment of risks, costs and benefits; the moral and ethical dimensions; the values of tangata whenua and other cultural values; and a range of other fundamental concerns.

In late 1998 the PCE began discussions with the Crown Research Institutes (CRIs) involved in possum biocontrol research. There was a collective recognition that, while millions of dollars were being spent to develop the science of biocontrols, separate research would be needed to establish whether or not any of the proposed biocontrol methods would be acceptable to New Zealanders, and to overseas markets for New Zealand products. It was acknowledged that many people would be unaware that biocontrols, particularly genetically engineered biocontrols, might be considered for use in the New Zealand environment, targeting a pest that is common even in the urban heartland. This seemed a very precarious platform from which to pursue solutions to New Zealand's number one pest, the possum. Thus this investigation was conceived, hopefully as one of many to explore the interface between science, its applications, and society.

1.2 This Investigation

1.2.1 The role and strategic approach of the Parliamentary Commissioner for the Environment

The Parliamentary Commissioner for the Environment is an Officer of Parliament, independent of Government, reporting to Parliament via the Speaker of the House. The functions of the Commissioner include:

- reviewing and reporting on the system of agencies and processes established

by the Government to manage the allocation, use, and preservation of natural and physical resources (section 16(1)(a) Environment Act 1986);
- investigating any matter in respect of which the environment may be or has been adversely affected, and advising on preventive measures or remedial action (section 16(1)(c));
- undertaking and encouraging the collection and dissemination of information relating to the environment (section 16(1)(f)); and
- encouraging preventive measures and remedial actions for the protection of the environment (section 16(1)(g)).

The PCE's previous work investigating pest management issues and technologies includes:

- *Investigation of the Proposal to Introduce Myxomatosis for Rabbit Control* – September 1987: An audit of the environmental impact report on the proposal by the Agricultural Pest Destruction Council to introduce myxomatosis for rabbit control in New Zealand.
- *Importation of Marron (Cherax tenuimanus): Investigation of the Ministry of Agriculture Approval Procedures* – June 1988: This investigation considered whether the legislation of the time was adequate to deal with the importation of exotic species such as marron, and whether MAF had adequately applied government policy relating to importation of exotic species, environmental protection and consideration of environmental risk.
- *Monitoring Report on the State of the Recommendations to the Director-General of MAF concerning the Importation of Marron* – November 1990: A report on the progress made in response to recommendations put forward in the 1988 report.
- *The Department of Conservation's Planning and Management for Control of Pests on Rangitoto Island* – December 1990: In response to objections concerning the use of 1080 poison in DOC's possum and wallaby eradication programme on Rangitoto Island, the PCE completed an investigation into the appropriateness of DOC's environmental planning procedures.
- *Possum Management in New Zealand* – May 1994: An investigation into:
  - the information available on the risks posed by uncontrolled possum populations and the statutory obligations of public authorities in relation to possum management;
  - the appropriateness of possum management methods and identification of areas requiring more research;
  - the adequacy of public authority consultation, coordination and decision-making on possum management; and,
  - appropriate possum management methods.

  The PCE's report considered the nature of the possum problem and management issues including the spread of Tb by possums, the use of 1080 poison, and the cost effectiveness and impacts of hunting and trapping. The report noted the potential development of a possum-specific biological control in 10-15 years (i.e. 2004-9) that might offer a cost-effective method to supplement or replace current control methods.

  The PCE recommended that release of genetically modified organisms (such as those envisioned for biological control of possums) not be allowed without formal approval based on an evaluation of likely environmental and social effects and public submissions (Recommendation 4(c)). The PCE also recommended that in research prioritisation, continuity of adequate long-term funding of biological control (including immuno-contraception) not be compromised (Recommendation 24), and that higher priority be given to research into (amongst other matters) the social and economic aspects of possum control, including public attitudes to control methods, and risk assessment.

- *Department of Conservation Possum Control on Mt Karioi, Raglan* – July 1994: A review of DOC's proposal to use aerial drop methods to carry out 1080 poisoning for the eradication of possums.

- *The Rabbit Calicivirus Disease (RCD) Saga, A Biosecurity/bio-control Fiasco* – September 1998: This report set out to examine the elements in the decision-making system, and farming business conditions that ultimately led to a major breach of New Zealand's biosecurity through the illegal importation of RCD into NZ.

- *Possum Management in New Zealand, Critical Issues in 1998, PCE Progress Report No 1* – November 1998: An evaluation of the progress made in implementing the recommendations from the 1994 report, and identification of strategic risks to effective possum control in the future. This update noted that, amongst a number of improvements, there still exist risks to effective possum control. These include the lack of research into understanding public attitudes and concerns, and the need for effective provision of scientific information to the public. In relation to biocontrol technology the update report highlighted the need for high standards of performance from organisations involved in quality assurance.

1.2.2 Terms of Reference - project goals and objectives

The principal goal of this investigation was to explore the range of views and concerns amongst New Zealanders about the use of biocontrols, some involving genetic engineering, for possum control. Specifically, the project's objectives were to:

1. Examine perceptions and attitudes among selected groups of New Zealanders (Maori and non-Maori) to the possible future use of a range of biocontrol approaches (including genetic engineering techniques) to manage the risks posed by possums to New Zealand. In particular, to examine reasons for perceptions of benefits and risks between different groups of New Zealanders towards different biocontrol approaches, and to put this in context with other methods of control and other relevant uses of biotechnology.
2. Examine information needs for debating biotechnology issues among different groups of New Zealanders (Maori and non-Maori), and who is trusted to fill these needs.
3. Develop processes for meaningful public debate and input into biotechnology and genetic engineering issues, using possum biocontrol as an example, and to identify areas within this debate where further examination or survey of public attitudes may be needed.

The Commissioner will report on:

- the investigation in his Annual Report to Parliament for the year ending 30 June 2000, and
- the outcomes of the investigation by September 2000.

1.2.3 Project partners

The Possum Biocontrol Project has involved the Commissioner working in association with the two Crown Research Institutes (CRIs) that have a major role in New Zealand's biocontrol research — Manaaki Whenua Landcare Research and AgResearch. Landcare Research and AgResearch were involved from the outset of the project, assisting with the development and application of the investigation methodology; providing advice on technical and scientific matters; participating in the meetings of the project's Reference Group; and contributing to the project financially.

It is important to note that this relationship was the product of a mutual interest in public perceptions of biocontrols, and genetic technology in general, given its fundamental importance to the future management of New Zealand pests, and how scarce research resources are applied. The Commissioner is independent of the Government, and has no direct involvement in the development or application of biocontrol methods or genetically modified organisms, in the ongoing work of the Crown Research Institutes, in genetic technology research, or in the consideration of applications to the Environmental Risk Management Authority.

1.3 Project Methodology

The project methodology had five components:

1. a Reference Group, providing advice, guidance, comments and practical contributions to the project;
2. a series of focus group meetings, exploring the responses of groups of New Zealanders to possum biocontrols – this component of the project is separately analysed and reported as Appendix A of this report;
3. meetings and interviews with tangata whenua, key interest groups, officials and agencies;
4. a commissioned paper on the ethical dimensions of the potential uses of biocontrol techniques for possums – included as Appendix B of this report; and
5. a review of the relevant literature from a wide range of sources.

1.3.1 The Reference Group

At the outset of the investigation, the Commissioner convened a Reference Group to provide advice on the project and on the wider issues and context. (The members are listed at the front of this report.) The diversity of backgrounds of the twelve members of the Reference Group is indicative of the diversity of interests and perspectives associated with the investigation topic – including veterinary science and animal welfare, the rural sector, scientific research policy, the activist groups opposed to genetic engineering, the media and communications sector, tangata whenua, conservation organisations, the biotechnology industry, regional government, and the social research sciences. Collectively the Reference Group members contributed an extraordinary richness of experience, expertise and knowledge to the investigation. The work of the Group was characterised from the outset by consistent respect for the views and concerns of others, allowing open dialogue, exchange of views and information, recognition of values, tolerance of differences, and a practical collaborative approach along with the CRI contributors and the PCE project team.

The Reference Group was brought together for four full-day discussion meetings during the course of the investigation, and gave input on various matters as the project progressed. The Group assisted with development and approval of the project methodology, and provided advice on the information pamphlet prepared for use with the focus groups (Appendix C). Reference Group members also helped organise and attended some of the focus group meetings, and contributed to the review processes for this report and other investigation outputs.

1.3.2 The focus groups

A range of methodology options for the exploration of public views and opinions were considered at the first meeting of the Reference Group. Options included public meetings, an extensive systematic survey of a random sample of the New Zealand population, a process of public submissions, a consensus conference with a panel of volunteers and experts, and focus group meetings. Focus groups have been described as group interviews based around a set topic or topics; interaction between members of the group is important to bring out information, responses and insights that would be less accessible in less dynamic settings. The Reference Group considered that focus groups, and hui with tangata whenua, would be the most effective and appropriate methodology for this particular investigation.

Two hui were held with tangata whenua. The first hui was held with individuals from Ngai Tahu and was included in the separate analysis of the focus group process (see below and Appendix A). Another larger hui was held in the Taitokerau with members of Northern iwi; this gathering was not included as part of the separate analysis of the focus group process, and is described below. (See 3.9.)

The focus group methodology was developed with advice from social science researchers working with Landcare Research, who had previous experience of using such processes to canvass public opinion on pest management issues in New Zealand. The social scientists were involved in all the focus groups, and subsequently undertook a separate analysis of this part of the process (Appendix A).

Two kinds of focus groups were organised: meetings with the "general public", and meetings with representatives of some of the range of groups with interests in possum management and the wider genetic technology debate. The interest groups included:

- scientists and public health professionals;
- people with an ethical interest and concern about the treatment of animals;
- practitioners, including farmers, foresters, pest control specialists, members of the biotechnology industry;
- people opposed to genetic engineering; and
- people with conservation and environmental interests.

Given that earlier work by the social science researchers had indicated that gender was a significant factor in the responses of members of the public to pest control issues, the meetings with the "general public" included one group exclusively comprising women, and another of men; both these groups were urban. The third "general public" focus group was organised in a provincial community, Levin, and (purely as a result of the self-selection of those individuals who

volunteered for the evening sessions) consisted predominantly of men. However in the researchers' analysis of the focus group discussions, no assessment was undertaken of any differences, or lack of them, that might have been identified in the responses of men and women participants in the respective groups, or within groups.

The Levin group was also used to trial a methodology where two group meetings would be held a week apart. The idea was to test the effects of information on the group's responses – although during the first meeting verbal explanations were given of the broader issues and the proposed biocontrol techniques, printed information was provided to participants only at the end of that meeting, for reading over the intervening week. The Levin group reported at their second meeting that the printed information had not significantly affected their thoughts and feelings on possums, biocontrols or genetic engineering, and they reiterated their positions from the week before. Therefore the double-meeting methodology was not repeated.

Focus group participants were provided with an information pamphlet outlining the nature of the possum problem and the various biocontrol methods presently being researched (Appendix C). This served as a basic framework for the discussions. The pamphlet outlines what a biocontrol is, and the intended effects of the possum biocontrols. The options include sterilisation via a toxin that targets hormonal processes, the development of genetically engineered techniques for contraception or sterilisation of the adult possum, and interfering with the survival of pouch young. The pamphlet lists some of the possible delivery mechanisms – genetically modified parasites or viruses, baits, aerosols, and transgenic plants – and also outlines some of the concerns and questions that have been raised about possum biocontrols and about genetic engineering generally.

The pamphlet was circulated to participants in advance of the meetings (except for the Levin group as noted above). A more detailed technical paper (Appendix D) was also made available at the focus group meetings. But the most valuable source of information for the groups was the senior research scientists working on possum biocontrol projects, one of whom attended every focus group meeting and hui to answer technical questions and clarify scientific matters. Many of the meetings were personally challenging for these scientists, and discussion about scientific and research issues often became very intense; nevertheless their participation, their openness about their work, and their helpful explanations were critical to the focus group meetings.

The focus group discussions were based around a standard set of questions, introduced by the session moderator. Additional questioning followed the directions taken by each particular group and, in many sessions, these digressions and tangents overtook the pre-prepared question format, making for extremely lively debate and interaction between members of the group. The process encouraged participants to:

- examine their views and understanding of the possum problem;
- discuss their attitudes to the use of biocontrols in general;
- evaluate a number of different biocontrol options for possum management, including those involving genetic engineering;
- consider their attitudes and concerns about genetic engineering in general;
- discuss with a practising scientist the technical aspects of biocontrol research and its potential applications; and
- identify critical issues for the future development of biocontrol technologies.

Issues regarding the provision of information were also discussed – what kinds of information are necessary for decision-making, who should provide it, how should it be communicated, and which sources of information (i.e. from whom) do people trust?

1.3.3 Wider consultation and research

In addition to the focus group process the investigation was informed by the PCE team's consultation with interested parties and individuals from a wide range of organisations and official agencies. The diversity of people interviewed reflects the diversity of issues, perspectives and concerns surrounding pest management, possum control, and the possible future role of genetic sciences in New Zealand. (A list of interviewees is given in Appendix E). Inevitably there are many people and groups whom it was not possible to consult in the time available.

A hui was held at Mangamuka Marae, facilitated by Te Kotahitanga o Te Taitokerau, and attended by people from many Northern iwi. In the early 1990s Mangamuka was the site of passionate protests from tangata whenua against aerial 1080 poisoning operations undertaken by the Department of Conservation; some of the kaumātua and kuia and others who had been involved in those protest actions participated in the biocontrols hui. The PCE investigation team also had other discussions with environmental management representatives of other iwi and hapū responding to proposals for GE or biocontrols in their rohe, and with Nga Kaihautu Tikanga Taiao, the Maori advisory committee to ERMA.

A meeting was arranged with a group of farmers at Tinui in the Wairarapa. Farmers - as the sector within New Zealand society with extensive "hands-on" interactions with possums, as well as being directly economically affected by possums' depredations and the costs of pest management – were an important group with whom to discuss biocontrol issues. The Tinui valley community has previously been involved in extensive possum control programmes using 1080, and in studies undertaken by Massey University on the spread of bovine tuberculosis.

Information and commentary on various aspects of the issue were also collated from official sources, from the published literature, from the news media and from the internet. In the interests of length and readability, this report does not include specific references to the majority of the reports, articles and ideas gathered together as the investigation proceeded. However the diverse materials accumulated in our research provided a rich and often thought-provoking background to the work of the investigation and the development of the conclusions and recommendations.

This report includes a range of different forms of information, including what some may consider "anecdotal" comments or the personal views of those interviewed. Where this type of information is included, it is reported as the perspective of those concerned, and should not be taken as an expression of the views or opinion of the PCE. The intention in using such information has been to reflect more accurately the range of experiences and concerns surrounding possum biocontrols and genetic engineering.

1.3.4 Commissioned paper

A study was prepared for this investigation on the ethical dimensions of possible future uses of biocontrols for possums, and of genetically engineered methods. The issues addressed in this paper were included in a presentation to the Reference Group as the project was taking shape, and was the basis of considerable discussion. A summary is given at 2.8 below, and the paper is attached as Appendix B.

1.4 What This Investigation Is NOT

It is important for the integrity of the Possum Biocontrol Project, and the clarity of its findings and recommendations, to highlight what the project is **not.**

The evaluation or determination of public acceptability is a two-step process that requires firstly a description of the range of views, and secondly an identification of how widely these views are held. The former is a qualitative task, the latter a quantitative one. This investigation has determined the range of views regarding the use of biocontrols for possum management, including the use of genetic engineering. It has necessarily, in the identification of participants for the focus group process and the other interviewees and consultation, worked to the principle of selecting typical, representative or indicative groups and individuals; there was not the scope or budget to undertake a fully comprehensive consultation process. Therefore this study is a qualitative assessment; it is **not** a quantitative assessment. Although from the limited range of people consulted some clear trends, priorities and emphases can be discerned, this investigation does **not** claim to determine how widely the views identified are held across the spectrum of New Zealand society.

The report describes the range of public acceptability associated with different biocontrol methods, and the reasons behind the views. The report does **not** provide a critical technical appraisal of the actual science behind these methods, nor does it explore the technicalities of how the proposed methods are intended to affect possum physiology. It does **not** undertake a scientific evaluation of the likelihood of other possible effects of application of such biocontrol techniques, or of the range of possible

unintended effects of this technology on other species, the wider environment, ecosystems or natural processes.

The investigation focuses on the possible uses of new biotechnologies for possum control. While a brief summary is given of the severity of possums' impacts on the New Zealand environment and the systems in place to deal with possums, this study is **not** a report on pest management or possum control programmes. It offers merely brief contextual indications of the damage wrought by possums, the extent of the risks posed by possums to our unique biodiversity and our overseas exports, and the potentials of utilising possums for their fur – but the investigation could **not** go into detail on these aspects of New Zealand's possum problem. (For specific information on possums and possum control, see the recent collection of technical essays published by Landcare Research, *The Brushtail Possum: Biology, Impact and Management of an Introduced Marsupial*, edited by T. L. Montague.)

The investigation has brought together a range of relevant information which the PCE will convey to key interests and agencies involved in research and consideration of proposed applications of the new biotechnologies. This study is an exploration of public concerns about these technologies, and some of the issues that need to be recognised, respected and effectively provided for in the policy and decision-making processes for biocontrols and the possible use of genetically modified organisms in pest control. This investigation is **not** part of the formal process of decision-making on any particular applications to the Environmental Risk Management Authority (ERMA) under the Hazardous Substances and New Organisms Act (HSNO Act). It does **not** undertake a detailed consideration of those formal processes, of the statutory and regulatory provisions, or of their adequacy or effectiveness for fulfilling their stated purposes or achieving quality environmental outcomes.

1:1 For example: R Wilkinson and G Fitzgerald: Public perception of pests in New Zealand: essential information for moving forward. www.landcare.cri.nz/conferences/manaakiwhenua/papers/index.shtml?wilkfitz; R Wilkinson and G Fitzgerald 1998: *Public Attitudes to Rabbit Calicivirus Disease in New Zealand*. Landcare Research Science Series 20, Lincoln, Manaaki Whenua Press; G Fitzgerald, L Saunders and R Wilkinson 1996: *Public Perceptions and Issues in the Present and Future Management of Possums*. MAF Policy Technical Paper 96/4; The Great Lake Pest Summit issue of the *NZ Journal of Zoology 20*, 4, May 1993; G N Kerr and R Cullen 1995: Public preferences and efficient allocation of a possum-control budget. *Journal of Environmental Management 43*; P M Blaschke, P G Hughes and D B Gibbs 1994: An overview of pest-people-resource relationships in New Zealand. *Proceedings: First Australian Landcare Conference*, Vol 2, Hobart.

1:2 Hon Marian Hobbs: Royal Commission on Genetic Modification. Media Release 17 April 2000.

1:3 G Fitzgerald, L Saunders and R Wilkinson 1996: *Public Perceptions and Issues in the Present and Future Management of Possums*. MAF Policy Technical Paper 96/4.

2. CONTEXTS

2.1 Introduction

There are a range of contexts - social, political, cultural, economic, scientific and environmental - within which New Zealand researchers have been developing proposals for new biocontrol methods for possum control. Most of the future possum biocontrol mechanisms currently being researched by New Zealand CRIs involve genetic engineering (GE). Possum biocontrols thus combine one of the most controversial scientific fields of our times, GE, into the already contentious arena of vertebrate pest management. The new proposals for dealing with possums therefore bring with them a complicated array of questions from these highly-charged contexts. Recognition of the background dimensions, and of wider social, political, environmental and scientific developments, is a crucial starting point for New Zealand to begin assessing the risks and benefits of particular biocontrol techniques.

2.2 Possums In New Zealand

2.2.1 The possum problem

The Australian brushtail possum (*Trichosurus vulpecula)* is a marsupial that was introduced to New Zealand between 1837 and the 1920s in order to establish a fur trade. Lacking natural predators, possums quickly spread throughout New Zealand. Population estimates carried out in the 1980s suggested that possums numbered approximately 70 million - with average densities up to 20 times greater in New Zealand than in similar Australian habitats. Possums now occupy more than 95% of New Zealand's land area, as well as some off-shore islands.

Possums have been termed New Zealand's number one vertebrate pest, in both economic and ecological terms. They pose a huge risk to New Zealand's biodiversity. Thousands of tonnes of native vegetation are consumed each night, degrading the quality and viability of indigenous forest ecosystems. Possums compete with native animals for food, raid birds' nests, and eat native snails and insects. Possums cause major damage to forestry, horticulture and primary production sectors, and spread tuberculosis to cattle and deer herds. The presence of bovine tuberculosis in New Zealand is a significant threat to international trade and overseas markets for our primary products. Possums also can carry diseases such as giardia and cryptosporidium, which might pose a risk to human health. The economic losses directly attributable to possums have been estimated to be between $40 million and $60 million a year.[2:1]

2.2.2 What is being done now to control possums?

Two control methods are primarily used to keep possum numbers in check: poisons and trapping. The principal poison used in New Zealand is sodium monofluoroacetate (1080), applied aerially or administered through bait stations on the ground. New Zealand does not manufacture 1080; the active ingredient is imported from the US and made into baits. New Zealand uses 85-95% of the 1080 produced in the world. Other poisons, such as cyanide, brodifacoum and cholecalciferol, are used to a lesser extent.

A relatively small number of possums are shot. Other control methods include excluding possums from certain areas via fences, sleeves on tree trunks, and chemical repellents; these methods do not reduce possum numbers but simply displace animals or protect trees.

Existing control mechanisms for possums cost government and councils more than $60 million a year. This sum does not include the significant amount also spent by private individuals, businesses, and organisations on possum control, estimated at $74.8 million per annum.[2:2]

In the July 2000 Budget the Government announced increased funding of $3.5 million for bovine tuberculosis vector control. In addition funding was provided for implementation of the New Zealand Biodiversity Strategy, which included a further $57 million over five years for pest control on public conservation lands.

Box 2: A New Zealand Fur Industry—A Possumable Dream?

In recent months the debate over killing possums has taken a familiar turn - develop an industry based on utilising New Zealand's number one pest. Possum fur is promoted as offering the potential to increase export earnings and reduce unemployment, while contributing to one of New Zealand's largest conservation challenges - getting rid of possums.

A New Zealand possum fur industry is not a new idea– possums were originally introduced to provide a fur resource. At its peak in the late 1970s, about three million possum skins were exported per year. However, in the early 1980s fur fell out of fashion, pelt prices dropped from $12 to $2, and New Zealand's possum fur industry collapsed.

The revival of interest came in the early 1990s with the development of a fibre of blended possum fur and merino wool that is used in the manufacture of high-value export textiles and garments. Ironically, the main constraint on industry growth is a shortage of possum pelts of sufficient quality.

Late in 1999 Deputy Prime Minister Jim Anderton, put forward a proposal for a government-assisted possum trapping programme with the combined objectives of creating employment and removing possums. However, the effectiveness and viability of a possum fur industry have been challenged: "The idea of sending out unemployed people to trap possums for an export fur industry sounds great in theory, but in practise would subsidise a marginally viable industry without achieving forest conservation or animal health goals".[F:1]

A number of issues have been raised:

- When the possum population density decreases, the cost of collection increases, and thus there is a strong incentive for commercial hunting operations to maintain population densities at a level that provides for least cost extraction. This level is likely to be a much higher density than that required to achieve conservation objectives. It is argued that commercial hunting is unlikely to achieve the required reduction in populations unless the value of possum products, and thus possums, is very high.
- Over the last two years the price for possum fur has increased from $30/kilo of plucked fur to $55/kilo (20-25 possums yield a kilo of fur). Experienced trappers have estimated that $80/kilo is the break-even point for a viable trapping industry. Given current fur price levels, some in the industry suggest that a government "top up" in the form of a bounty would help: "Even a Government bounty of $1 a skin would go a long way towards resurrecting the industry".[F:2] A possum bounty was paid in New Zealand for ten years (1951-1961); during the bounty period actual possum numbers and distribution are believed to have grown.
- Trapping reduces pest numbers in easily accessible areas, but not in remote or challenging terrain. As a result, possums can continually recolonise the same territory. Areas prioritised for fur collection may not overlap with areas prioritised for conservation purposes or Tb vector control. But if trappers and hunters focus attention on areas that are easily accessible, then councils can focus their possum control efforts in more remote and challenging areas.[F:3] It is believed that a combined approach will dramatically increase the potential effectiveness of eradication/control efforts.
- Others have challenged the promotion of this type of industry due to the fickleness of the fur and fashion market.
- The wisdom of creating jobs and infrastructure that depend on a resource that is in New Zealand's broader interests to eradicate has also been challenged.

In some areas, training programmes and work schemes have been developed in order to meet the requirements of a possum fur industry. The Nelson Kahurangi Employment Trust offered one of the first possum-plucking courses; in addition to fur-plucking techniques, trainees are taught a wider suite of pest management skills. A programme based at Pakanae Marae in the Taitokerau, organised by the Taitokerau Organic Producers Society, recently produced 21 graduates trained in the use of poisons, traps and shooting, as well as fur-plucking machines.[F:4]

The ultimate success of these programmes mandates a philosophy and approach that is more than "just chasing fur".[F:5] Amongst other things, the viability of trapping work schemes will require an

understanding of pest management strategies, and will depend on such factors as the extent of forested area in the region, the density of the possum population, and the range of other employment opportunities available.

Currently the reliance on one end product (fur) limits the income potential for hunters. While there is much local enthusiasm for turning possums into a raw material destined for further processing and export, until fur prices increase or other end uses for the product are developed, the current returns will remain unattractive for hunters.[F:6]

Possum meat export offers another option. Exotic Game Meats, New Zealand's sole exporter of possum meat, presently exports small amounts of possum to Taiwan and Hong Kong at $NZ23/ kilo; China has also expressed interest. Admittedly, the future of these opportunities is limited due to the fact that the meat must be Tb-free, and only Northland region currently has that rating for export purposes.

F:1 Forest & Bird, Evening Post: 6 December 1999.
F:2 Dave McKinstry, of Possum Pam. In: Possum power fuels jobs dream. New Zealand Herald, 1 December 1999.
F:3 Andy Crichton, Southland District Council, personal communication.
F:4 Taitokerau Possum Control Group. Landlink, Newsletter of the NZ Landcare Trust, Winter 2000 issue, p 3.
F:5 Andy Crichton, Southland District Council, personal communication.
F:6 Enterprise Connections Staff, Southland District Council: Possum Industry Potential for Southland —Background Paper.

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Anderton backs possum jobs. Evening Post, 13 December 1999.

Bennett, J. 1994. Cost-Benefit Analysis of Possum Control in New Zealand. Masters Thesis: Victoria University.

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Parliamentary Commissioner for the Environment. 1998. Comments on Petition of Simon George Leake and 11,600 Others and Petition of John Weston and 23,425 Others. Response request by House of Representatives Primary Production Committee.

Possums could be big earners in China. New Plymouth Daily News, 25 April 2000.

Possum plucking techniques taught. The Dominion, 24 May 2000.

Possum power fuels jobs dream. New Zealand Herald, 1 December 1999.

2.2.3 Problems with the current methods

For many years now there have been doubts amongst pest control professionals whether New Zealand's current possum control technologies will be able to reduce the possum population to desired levels or eradicate the pest altogether. Not only are there questions about the funding levels that would be required, and the ongoing commitments that would be necessary, but it is recognised that our present "toolbox" of control mechanisms may not be sufficient or sustainable:

- Many people, both in New Zealand and in our overseas markets, have concerns about poisons being used for pest control.

- Pest control methods considered inhumaneare becoming unacceptable to many people in New Zealand as well as to many of our overseas markets.
- Poisons have unintended lethal effects on other animals such as dogs, livestock, some native birds and insects.
- Over time possums may develop a resistance to poisons or may learn to avoid baits and/or bait stations.
- Trapping may also kill or injure other species, including endangered birds such as kiwis.
- Possums are widespread throughout New Zealand, but control work is focussed on the worst affected or highest priority areas. Some private landowners may not be able to afford expensive possum controls.

2.2.4 Alternative approaches - possum biocontrols

The National Science Strategy Committee (NSSC) was established in 1991 to promote and co-ordinate national scientific research efforts into possum and bovine Tb control. The NSSC has organised a series of workshops on biocontrol of possums, involving researchers from New Zealand and overseas, and believes that current possum control methods could in future be combined with biocontrol technologies for a more effective long-term solution to New Zealand's possum problem.

New Zealand scientists have been working for some time to develop complementary ways of controlling possums. Attention has been focused on a range of biocontrol methods, some using genetic engineering:

- parasites and diseases that might reduce possum numbers;
- methods to attack key physiological processes in possum fertility, disrupting breeding and the survival of pouch young; and
- mechanisms for delivering a biocontrol to possums, including baits, aerosol sprays, genetically modified plants (whether native or exotic species), and naturally spreading possum-specific diseases or parasites.

At the recent NSSC workshop, "Possum and Bovine Tb Management in 2010", technical reports were given on research into fertility control techniques (including immunocontraceptives, blocking early embryonic development, or disabling reproductive function), control of lactation processes to affect pouch young, and delivery systems (including oral delivery, viruses, bacteria and parasites).[2:3]

Given the possible implications of such technologies for Australian possums and other marsupials (such as the Australian national icons, the kangaroo and koala), New Zealand researchers are working in close association with the Cooperative Research Centre for Conservation and Management of Marsupials, based at Macquarie University in New South Wales. The Marsupial CRC integrates fundamental and applied research to develop appropriate management techniques including systems for regulation of the fertility of marsupial populations, characterisation of the marsupial immune system and its manipulation, and computer models of marsupial population management.

In New Zealand about $5 million a year is spent on researching biocontrols for possums. Most of the research is carried out by two Crown Research Institutes - AgResearch and Landcare Research. This work is now close to the stage where decisions will need to be made by research agencies and funders on which techniques to give priority for further development and testing.

2.3 Research and Funding

As noted above the national research effort for possum control is co-ordinated by the NSSC for Possum and Bovine Tuberculosis Control; administration is in the Foundation for Research Science and Technology (FRST). The NSSC's terms of reference include:

- developing a comprehensive science strategy for research into possum and bovine Tb control;
- developing a co-ordinated, national research portfolio;
- providing advice to the Board of FRST on its investment;
- promoting and progressing the application of science.

The total investment in possum and bovine Tb control research in the 1999/2000 year was $14.8 million with the principal contributors being FRST ($7.22 million), MAF ($2.95 million), the Animal Health Board ($2.69 million) and DOC ($0.83 million).

The research funds are spent primarily on management of bovine tuberculosis ($5.26 million) and the development of biocontrols for possums ($5.31 million). A smaller and decreasing amount is allocated to researching conservation impacts and current control methods. To date the main emphasis of biocontrol research and of the NSSC has been on the technology; some projects have looked into the wider context of public opinion or potential environmental effects, such as the mid-1990s survey of public perceptions of possum controls.[2:4] Workshops of pest control experts organised by the NSSC have endorsed the need for more of this kind of research.

The Foundation for Research Science and Technology was established in 1989 to allocate funds for the production of outputs relating to public good science and technology, and to provide independent policy advice to the Minister on matters relating to research, science and technology, including advice on national priorities for those matters.

As at August 2000, the Public Good Science funds are allocated to projects within a series of Strategic Portfolios by a process of negotiation between FRST, the providers of the research and the users. The research effort for possum control is largely within two portfolios: Sustainable Management of the Productive Sector, and Advanced Biological Enterprises. Within the Advanced Biological Enterprises portfolio, FRST has emphasised that technological learning should also include the relevant regulatory agencies and the wider community, in recognition that this will be essential for open and informed public discussion on emerging technology and its possible applications. More specifically FRST has recognised that the increased research effort in biocontrols needs to be accompanied by research into issues relating to social and cultural acceptability. The Foundation has explicitly stated their support for projects that characterise the risk of adverse effects of any new control technologies for both human and ecosystem health. (See 3.22).

2.4 New Zealand Biocontrol Trends

Over the last 25 years the trends in pest control worldwide, particularly for insects, have been increasingly towards biological methods – parasites, viruses, pathogens, pest resistant plants, and crop management techniques – and New Zealand has followed these worldwide trends. This focus on biological management has intensified in export horticultural crops (kiwifruit and pipfruits) as consumers throughout the world demand pesticide-free fruits and foods. Biocontrols have proven successful in New Zealand for a number of insect pests of cereal crops, greenhouse and orchard crops, pasture grasses, eucalypts and radiata pine. There has been similar emphasis on biocontrols for conservation purposes – weed species currently being targeted by biocontrols include gorse, old man's beard, Saint John's wort, heather at Tongariro National Park, and mist flower in Northland and Auckland. And there are plans for carp to be introduced to clear waterweeds clogging lakes and streams.

Biocontrol involves using biological means to control a pest, rather than chemical means (poisoning, repellants) or physical means (trapping, shooting, fences). The principle is to introduce an agent or organism that will attack the target pest species, and will become self-sustaining in this control niche, thus requiring little or no further human management or expense. Considerable economic benefits have been achieved from successful biocontrols of pests of production crops and plants – cost savings include significant reductions in pesticide use.

Biocontrol agents can include predators of the target species, viruses, bacteria or fungi intended to cause disease, and parasites. Biocontrol can also be achieved for various pest species by such methods as:

- artificial selection of target species for natural resistance to pests and pathogens;
- using natural pheromones to disrupt insect behaviour;
- manipulating farming practices to induce habitat change and make ecosystems unfavourable to pest species;
- specialist planting to create environments to encourage pest predators; or
- genetic modification for resistance.

New Zealand has a long history of introducing potential biocontrol agents; since 1874 over 300 species have been introduced to these islands with the intention of controlling vertebrate and insect pests and weeds. Early attempts such as the 19th century initiatives to control rabbits with a suite of predators – cats, ferrets, stoats and

weasels – often only resulted in increasing the number of pests in the landscape. Other difficulties have included the failure of many biocontrol agents to become established in their new environments, and a number of biocontrols that have been less than fully effective in controlling their intended targets.

In recent decades introductions have been preceded by more rigorous assessment, and there has been greater emphasis on the specificity of a proposed biocontrol to its target species. In contemporary assessments of the risks and benefits of biocontrols for New Zealand, the potential risks to native plants, animals and insects are a prime focus. Judging the likely effectiveness of a potential biocontrol agent is also part of the evaluation and decision-making processes.

It is now normal practice to have multiple releases of a new biocontrol at different sites, in different seasons and in successive years, using computer simulations to predict ways of maximising the chances of the biocontrol becoming established amongst its target species. Weeds and pests may be subjected to a number of different biocontrol agents; for example, seven separate biocontrols have been used to target gorse since 1931. And a single biocontrol agent may impact on more than one pest species.

Biocontrol agents cannot often achieve the rapid and dramatic "knock-down" effects of other forms of control such as agrichemicals. Some biocontrol agents may never achieve total eradication of the target species, but will still be effective enough to be considered important tools in an integrated pest or weed management programme. The impacts of biocontrols can vary from season to season, and from region to region. Ongoing monitoring over the long term is crucially important to assess effectiveness, and to identify any unexpected consequences or impacts on non-target species.

A characteristic of most biocontrol approaches to pest management in current crop and fruit production systems is that they are high-skill systems. Compared to chemical control systems, biocontrol methods tend to be knowledge-intensive, in regard to the knowledge and skills of the operator or farmer, rather than material-intensive. They require thorough understanding of the ecology of the whole production system, and the ability to assess exactly when, and with what, to intervene. Biological control systems for possums will probably also be highly knowledge-intensive.

2.5 Genetic Science

2.5.1 A rapidly developing technology

Researchers first discovered how to transfer a particular piece of genetic code from one organism to another in the 1970s. This field of science has gained a high public profile in the second half of the 1990s, with exponential increases in the capabilities and sophistication of genetic science and technology, and its proposed application for a wide range of purposes (see 2.6). Genetic engineering and genetic modification have been advanced as an answer to all kinds of problems facing humanity – some more urgent and fundamental than others.

Most public concern has been focused on applications of genetic technologies to food and fibre production. The second half of the 1990s has seen a rapid expansion in the use of GE in agriculture, with the development of rot-resistant tomatoes, and varieties of cotton, corn, soybeans and canola engineered for herbicide tolerance or resistance to insect damage.

More recently, researchers have been working on applications of genetic science with the goals of:

- the development of pastoral technologies (modifying clover and ryegrass to improve livestock nutrition);
- the modification of rumen bacteria to reduce the emission of methane gases which contribute to global warming;
- the enhancement of staple foods such as rice to fight Third World hunger and malnutrition; and
- the development of crop varieties that will tolerate harsh growing conditions and degraded lands:

> The tools of gene technology offer… the potential to develop new varieties of crop plants that can be productively grown in less arable soils, and to design plants [with] tolerance to salt, drought and aluminium toxicity.[2:5]

These new food and crop technologies have generated considerable concern and opposition amongst the general public, different groups and sectors in society, and within the scientific community. There have

also been various advocates and champions for genetic engineering-based biotechnology and its potentials, particularly amongst scientists and life science companies seeking to diversify away from agrichemicals. The controversy over genetic engineering has largely been oriented around a few "icon" applications of genetic science, such as:

- Monsanto's Roundup®-ready soybeans and canola, resistant to the herbicide Roundup® (glyphosate), thus allowing a broad spectrum herbicide to be used; or
- plants incorporating genetic material from the natural toxin *Bacillus thuringiensis* (Bt) to control insect pests.

The debate has intensified rapidly, and is often polarised between opponents and supporters of the new technology. Campaigns and protests against GE have employed a range of sometimes dramatic tactics to draw attention to possible risks and potential adverse effects; the goal of these efforts has been to encourage more testing, more stringent regulations, labelling of foods, and application of the precautionary principle. (see Box 5: Precautionary Principle)

Public concern is based in deep anxieties about the technology itself, lack of information regarding the workings of the science, intense concern about its potential unintended adverse effects, awareness of negative effects of earlier technological introductions, and distrust of scientific organisations, regulatory agencies and the corporations responsible for its development and release into fields and markets. The US agrichemical and pharmaceutical corporation Monsanto has a high profile and attracts passionate hostility. The controversy around genetic modification of major food crops, such as soy, corn and canola, reflects a sense amongst those concerned about GE that the principal objective of these technologies is to increase profits for private industrial and agricultural interests:

> It's not science that has lost us control of the crops in our fields. It's the rush for profits by biotech companies chasing new markets, and the sluggish response of governments in regulating them.[2:6]

Other applications of GE, particularly in the medical area, have generated less public concern, perhaps because such applications are perceived to take place in containment, to provide significant benefits to those receiving the treatment and, most importantly, are a matter of individual choice. Diabetics all around the world, including 15,000 New Zealanders, "depend on bacteria genetically modified to carry the human gene that produces lifesaving insulin".[2:7] GMOs and GM products are used in many areas of medicine including research, diagnosis, treatment and prevention of disease as well as in forensic medicine. Medical applications of genetic science include: production of human hormones to treat growth defects, treatments for cancer and arthritis, vaccines to fight hepatitis and other major diseases, and screening for inheritable diseases. More controversial proposals include genetically modifying animals to produce substances and organs for human treatments or transplantation. There are up to 300 GM-based medicines in clinical development in the US, and up to 30% of new drugs reaching the market are GM-based.

The controversy continues, with such developments as the compensation paid to French farmers when rapeseed crops discovered to have contained GM material were ordered destroyed by the French government,[2:8] and the media reports of research suggesting that genetic material used to modify crops can cross the species barrier. A German study found that "the alien gene used to modify oilseed rape could contaminate bacteria in the guts of bees".[2:9]

2.5.2 Wider safety issues

The debate about genetic science has been part of, and influenced by, wider global debates about health, safety and science that gathered momentum and intensity through the 1990s. British beef herds' infection with bovine spongiform encephalopathy (BSE or "mad cow disease"), from feed supplements that included meat and bone meal from other animals, was one of a number of European health scandals that contributed to public concern over food safety, and eroded confidence in government food assurance systems and approval of the application of new technologies:

> Repeatedly, the BSE crisis was mentioned in support of people's expressions of unease at possible dimensions of biotechnology. Not only was the recent history of official handling of that crisis

> used to illustrate a perceived tendency towards mendacity and 'cover-up' where powerful industrial interests were at stake, but it was also held to show the unreliability of 'scientific' reassurance in such fields.[2:10]

Other trends of public concern, such as the late 1990s' opposition to increasing trends of globalisation and corporatisation, have also helped shape responses to genetic technology. There was intensive media coverage as tens of thousands of people protested in the streets of Seattle at the November 1999 meeting of the World Trade Organisation, in Montreal in January 2000 at the meeting for the Biosafety Protocol, in Boston in March 2000 at the Bio2000 Conference of biotechnology industry representatives, and in Melbourne in September 2000 at the World Economic Forum.

2.5.3 Responses to public concern

Globally there have been a range of responses to public concerns about GM food and technologies. Supermarket chains in the UK and Europe are featuring GE-free produce, and major food companies, such as Heinz-Watties, Unilever and Gerber, are publicly rejecting genetic technologies and promoting their products as GE-free. The value of Monsanto company stocks declined significantly over 1999[2:11] and through 1999 the financial community noted the declining value and advisability of investment in biotechnology.[2:12] Recent increases in world markets for organic produce can be seen as a direct reflection of societal concerns about food and environmental quality (although organics are yet only a very small proportion of total production). There is considerable enthusiasm for the future of New Zealand's organic exports among some farming and political interests:

> Demand for organic food is one of the fastest growing segments of an otherwise oversupplied world food market… Organic produce has been used by some companies to pioneer the kinds of traceability and audit systems that high-value purchasers like British supermarkets are increasingly demanding for all their produce.[2:13]

Some governments and regions have decided against using genetically modified organisms, or established moratoriums in order to consider the issues involved.[2:14] And the Prince of Wales has spoken out controversially on agriculture, genetic science and ethics:

> If literally nothing is held sacred any more, what is there to prevent us treating our entire world as some "great laboratory of life" with potentially disastrous long-term consequences.[2:15]

2.6 Genetic Science in New Zealand

In many countries including the United States, Canada, Argentina, Chile, China and South Africa, GM crops are extensively grown. In New Zealand, genetically modified plants and organisms are presently approved only for projects in containment, either in the laboratory or for field trials. No commercial growing of GM crops has yet been undertaken in New Zealand. Early in 1999 Monsanto considered lodging an application to grow crops of GE canola in Canterbury, but did not proceed.

Medical applications of genetic science in New Zealand include research into the genetic basis of diseases such as cancer, respiratory disease and arthritis. GM reagents are used in research for testing, and in many diagnostic tests; GM animals are used to investigate the basis, diagnosis, treatment and prevention of disease. A number of GE-based medical treatments are used in New Zealand such as insulin (for diabetes), tPA (for heart attacks), growth hormone and FSH (for hormone deficiencies). The current moratorium on the release of GMOs resulted in the withdrawal of a cholera vaccine from the New Zealand market. Genetic science is also being used by New Zealand researchers to develop a therapy for stroke and brain injury; in the development of products to reduce the incidence of rheumatic fever and heart disease; and to determine an improved rationale for the treatment of depression. Recently a gene therapy trial was carried out in Auckland on a patient with a terminal brain disorder.

Genetically modified organisms were used in the development of DNA fingerprinting, which also uses GM-based reagents. DNA fingerprinting is extensively used in New Zealand forensic work to investigate crimes such as rape, murder and assault.

Concern over the safety, ethics and acceptability of genetic technology has escalated in New Zealand through the late 1990s. The issues gained notoriety with the direct action of the Wild Greens, a protest group who uprooted a trial crop of GM potatoes in Canterbury in early 1999. Applications for controversial GM technologies to ERMA have attracted media attention and public protest.

2.6.1 Environmental NGOs

The environmental and conservation non-government organisations (NGOs) have been active in response to the new technologies.

Greenpeace has one of the most high-profile campaigns against GE. Globally and in New Zealand, Greenpeace has taken an active role leading the opposition to genetically modified foods and genetic technology in general. For ten years the organisation has been running a campaign to stop the irreversible release of genetically modified organisms into the environment. In New Zealand, Greenpeace has established a consumer network organising opposition to GM food under the auspices of its True Food Campaign.

Forest and Bird, New Zealand's most well-established nature conservation organisation, does not have a particular policy position on genetic engineering. However, Forest and Bird has considered GE issues within the perspective of biodiversity and the requirements of conservation. Forest and Bird advises a precautionary approach because of the potential risks to New Zealand's biodiversity from self-spreading GM organisms. Additionally, from the perspective of conservation where the imperative is to protect New Zealand's biodiversity, there is scepticism about biocontrol methods that target fertility rather than killing possums directly and reducing possums' pressure on forests.

ECO (Environment and Conservation Organisations), a coalition of NGOs, has given some consideration to genetic technology, and contributed to the development of the *Vote for the Environment Charter* for the 1999 election, which stated that: "The protection of biodiversity should take precedence over the high-risk strategy of allowing the release of genetically engineered organisms in to New Zealand and genetically engineered ingredients into the human food chain". While it is acknowledged that there is a range of views amongst ECO's member organisations, the following resolution was passed at the 1998 ECO Annual General Meeting:

Moved that: while opposing the release of genetically modified organisms, ECO:

- supports mandatory labelling on all genetically modified foods where release has occurred;
- calls for an immediate moratorium on all transgenic field trials and releases; and
- calls for a ban on any genetic modification of biota for pharmaceutical production which could result in a release to the environment.

2.6.2 Animal rights groups

The work of animal rights groups is based on the belief that all life has the right to exist in its natural state, and that humans have no right to disrupt, affect, or harm animals in order to meet society's needs, values or desires. The humane treatment of animals is an increasingly important issue both nationally and globally; its capacity to affect New Zealand's overseas markets should not be underestimated.

The animal welfare group SAFE (Save Animals From Exploitation), founded in the 1930s, carries through the principles of respect, appreciation and compassion for all life (whether human or animal) in its campaigns. SAFE has a policy opposing genetic engineering completely, and considers that genetic engineering, and the application of technology in general, are advancing far ahead of society's ethical frameworks:

> The notion of animal rights may be permanently lost through genetic engineering of animals. You don't engineer animals, you engineer machines, and … machines have no rights. As a result of genetic engineering, animals' very beings are teetering on the brink of becoming lost forever.[2:16]

The RSPCA (Royal Society for the Prevention of Cruelty to Animals) also has a national policy opposing GE, but does not oppose the use of "genetic manipulation where it offers the opportunity to improve animal health, animal production, or the capacity of any animal to better adapt to the environment in which it is usually kept".[2:17]

SAFE and the RSPCA both recognise the problems possums pose for New Zealand's biodiversity, and support progressive pest control measures. But this objective should be achieved in the most humane manner possible; these groups believe that animals should not be "demonised" as pests simply because they were introduced into an environment where they have adverse impacts.

2.6.3 Groups concerned about GE

The group GE-free New Zealand was established in July 1998 as RAGE (Revolt Against Genetic Engineering) to campaign against GE in food products and the environment. Its formation was motivated by the "release of a new untested technology being used in food production, without labelling, and without consumers' consent".[2:18] The organisation arranges petitions and protest action, makes formal submissions into ERMA application processes, and works to increase awareness with such events as a rally and music festival in Wellington just before the 1999 election. Its vision for New Zealand is GE-free food and a GE-free environment; the goal of its campaign work is to provide information about GE and genetically modified food so that consumers can make informed choices.

The group of concerned professionals, Physicians and Scientists for Responsible Genetics (PSRG), has also been involved in these issues. PSRG formed as a group of members initially concerned with the possible effects of GE crops on the environment and human health. Members believe that introducing GE into the food chain and the environment is highly premature, as safety testing has not been adequately carried out. Their purpose is to promote an international moratorium on the release into nature and use of GE organisms, and their use as food; they believe such a moratorium is urgently needed for the well-being of humanity and the biosphere. PSRG is internationally affiliated with Physicians and Scientists for the Responsible Application of Science and Technology, and were strong supporters of the establishment of a Royal Commission of Inquiry into all aspects of GE in New Zealand.

The Interchurch Commission on Genetic Engineering has been established to encourage debate and informed discussion within New Zealand churches on genetic science, from an ethical, spiritual and theological standpoint. The Commission has members from the Anglican, Methodist and Presbyterian churches bringing together expertise in medical, scientific, ethical and theological areas.

2.6.4 Official agencies

The following summaries outline the roles and responsibilities of agencies with particular regard to genetic sciences and their possible application in New Zealand. Other agencies such as the Department of Conservation, the Ministry for the Environment and the Animal Health Board also have significant interests in possible future genetic technologies in relation to their potential contribution to and impacts upon conservation, environmental and production livestock management; however, the official bodies with primary responsibility for genetic technologies are ERMA, IBAC and the Royal Commission of Inquiry.

2.6.4.1 The Environmental Risk Management Authority

The Environmental Risk Management Authority, commonly known as ERMA, is an independent expert decision-making body of eight members established under the HSNO Act to consider and decide on applications for the manufacture, import or release of hazardous substances and new organisms (including genetically modified organisms) in New Zealand.

In its assessment of applications ERMA is required (section 5, HSNO Act) to recognise and provide for:

- safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
- the maintenance and enhancement of the capacity of people and communities to provide for their own economic, social and cultural well-being, and for the reasonably foreseeable needs of future generations.

ERMA is also required (section 6) to take into account:

- the sustainability of all native flora and fauna and all valued introduced flora and fauna;
- the intrinsic value of ecosystems;
- public health;
- the relationship of Maori and their culture and traditions with their ancestral lands,

water, sites, wahi tapu, valued flora and fauna, and other taonga;
- economic and related benefits; and
- New Zealand's international obligations.

The legislation includes specific reference to the precautionary approach, with the requirement (section 7) that ERMA shall take into account the need for caution in managing adverse effects where there is scientific and technical uncertainty about those effects. And all persons exercising powers and functions under the HSNO Act are required to take into account the principles of the Treaty of Waitangi (section 8).

In 1997 ERMA established Nga Kaihautu Tikanga Taiao, an advisory committee to advise the Authority on matters of importance to Maori and the Treaty of Waitangi. Nga Kaihautu has provided advice to ERMA on specific applications for new organisms. A protocol was developed for taking account of the Maori perspectives and the principles of the Treaty of Waitangi; it sets out criteria for assessing quality in environmental, cultural, health and Treaty outcomes. Recently Nga Kaihautu advised against approval of an application to ERMA for a field trial of cattle containing human genetic material; the application was approved with conditions, and has now been appealed; Nga Kaihautu initially registered its interst in the appeal but subsequently withdrew. (See 3.20)

ERMA also has a role in increasing understanding of a range of matters associated with the new technologies. A priority in ERMA's work in these areas has been to provide information for potential applicants and submitters under the HSNO Act about the specific issues and procedures involved. ERMA has also organised conferences and events aimed at raising awareness amongst the wider public and various interested groups and sectors, such as the recent two-day seminar on *Gene technology in New Zealand: scientific issues and implications*.[2:19]

Box 3: Unauthorised Uses of Genetically Modified Organisms

In April 2000 ERMA issued a press release announcing investigations into the University of Otago Christchurch School of Medicine, where researchers had been developing genetically modified organisms without legal approval. Over the following weeks the Authority undertook a nation-wide check of research institutions, including crown research institutes, universities and private laboratories, to see if any other non-approved GM research was taking place. Examples of unauthorised research were reported at the universities of Otago, Canterbury, Victoria, Massey and Waikato and at the Crown Research Institutes Landcare and ESR.

At this point ERMA:
1. Suspended all delegations for decision-making on GMOs from the Institutional Biological Safety Committees;
2. Required all institutions doing GMO work to complete a detailed report to the Authority;
3. Began detailed investigations into situations where unauthorised work did or may have occurred;
4. Required institutions to terminate unapproved work and destroy the GM material or make an application to the Authority for approval.

A total of 27 institutions reported back to ERMA. These reports revealed 580 GM developments with appropriate approvals and 113 with no proper approval. While ERMA was satisfied that most of the unauthorised projects were low risk work, more detailed assessments were sought. It is of considerable concern that neither the individual scientists nor the research institutions saw the need to seek formal approvals, despite the high levels of concern in society and, politically, about some of the potential risks of genetic science.

This episode has been a "wake-up call" for the research community; ERMA is taking advantage of the raised awareness to put in place a more robust delegation procedure with revised instructions to Institutional Biological Safety Committees. Following investigation into the identified unauthorised projects, the Authority decided not to take any prosecutions under the HSNO Act.

2.6.4.2 Independent Biotechnology Advisory Council

The Independent Biotechnology Advisory Council (IBAC) was established in May 1999 as a response to increasing public and political uncertainty over biotechnology, particularly that involving genetic engineering. IBAC comprises ten members and is serviced by the Ministry of Research, Science and Technology. The Council's role is to:

- investigate generic environmental, economic, ethical, social and health issues relating to biotechnology;
- consult with interested and concerned groups and gauge public opinion on biotechnology and associated issues;
- communicate with the public; and
- inform government decisions on biotechnology.[2:20]

In mid-1999 IBAC released a discussion booklet, *The Biotechnology Question,* looking broadly at a range of aspects of genetic science. In September 1999 the Council was asked by the Minister for the Environment to consider the issues surrounding GE and its effects on New Zealand's trading position and image in overseas markets. At the end of the year IBAC published a discussion paper, focused specifically on a consideration of the economic implications of a first GMO release in New Zealand. The Council reported back to the Minister on the 39 submissions received in response to the paper, noting that since it commenced this project:

> …the decision was made to establish a Royal Commission of Inquiry into Genetic Engineering. It would thus be inappropriate for IBAC to make specific recommendations on the release of GMOs.[2:21]

IBAC has also released two reports on the public submissions received in response to *The Biotechnology Question*, and a series of focus group meetings undertaken in October 1999 with members of the public to discuss aspects of biotechnology.[2:22]

2.6.4.3 Royal Commission of Inquiry

The 1999 Labour Party manifesto committed the new Government to establishing a Royal Commission of Inquiry to investigate genetic modification in New Zealand. The Royal Commission was convened in May 2000, and is to report by 1 June 2001. While the Royal Commission is carrying out its inquiry and for three months subsequently, a voluntary moratorium has been negotiated between government and the industry and research agencies, on applications for field testing (with limited exceptions) or for commercial planting of genetically modified crops.

The Royal Commission is headed by Sir Thomas Eichelbaum, a former Chief Justice. The three other members come from a range of backgrounds and experience: medical practitioner Dr Jacqueline Allan, scientist Dr Jean Fleming, and Anglican Bishop the Right Reverend Richard Randerson. The Royal Commission's terms of reference are wide ranging, including consideration of:

- present New Zealand uses of GM;
- levels of evidence and levels of uncertainty about GM and its applications;
- risks, benefits and future opportunities from the use or avoidance of GM;
- New Zealand's international obligations in regard to GM;
- the Crown's responsibilities under the Treaty of Waitangi in relation to GM;
- global developments and influences; and
- areas of public interest in human health, environmental and ecosystem health, economic aspects, and cultural and ethical concerns.

2.6.4.4 Other agencies

Te Puni Kokiri, the Ministry of Maori Development, is also contributing to the GE debate with a survey of Maori views on GE and its possible applications. The work has been commissioned from a team of Auckland University researchers. This study is based on a series of extended interviews with iwi and hapū representatives working in environmental management.

The Australia New Zealand Food Authority (ANZFA) works in cooperation with a Council of Australian and New Zealand Health Ministers to develop food standards and other regulatory measures, and to promote the delivery of safe and healthy food by the food industry, and the provision of information to consumers.

It is illegal to sell any food produced using gene technology unless an application is made to ANZFA who carry out a risk assessment and invite public comment during the assessment process. Any approved products

must meet labelling requirements. New labelling laws will require that almost all genetically modified food sold in New Zealand from July 2001 is labelled as such. Foods with more than 0.1% of GE ingredients will require labelling, but campaigners for safe foods have raised their concerns about the exemptions to these provisions, which include food from restaurants and takeaway outlets and highly refined foods such as cooking oils or food colourings.[2:23]

The recent establishment of the Science and Innovation Advisory Council (SIAC) as an Advisory Council to the Prime Minister is a new initiative to address the interface between science and the New Zealand public. The Council will be a channel to facilitate "a two-way process in which ideas from the community inform Government policies, and Government leadership challenges community thinking about its commitment to science and innovation".[2:24] SIAC will have:

- a consultation role in which it discusses science and innovation issues of concern to the Government with interested groups in the community; and
- an advice role in which it synthesises feedback from the community and its own analysis of issues to provide advice on policies and actions for Government.

2.6.5 The production sector

In the production sector there has been a range of different responses to genetic science and its potential applications. There is a spectrum of opinion about the possible strategic advantages, and the risks, that GMOs might have on the market viability of New Zealand's exports, and on our international reputation as a "clean green" pastoral country.

Through the 1990s there has been an increasing focus on integrated pest management systems (IPM), which produce crops free of agrichemical residues for increasingly discerning overseas markets, and on organic production of fruit and vegetables. All New Zealand export kiwifruit is now either organic or from an IPM system called Kiwi Green. The pipfruit and wine industries are following similar directions. There is new interest in organic farming systems, with an investigation into their potentials being undertaken by Parliament's Primary Production Select Committee.

One recent survey of rural and urban New Zealanders found that:

> Amongst urban New Zealanders 12% believe the future of New Zealand agriculture lies with genetic modification and 78% with organic production; amongst rural New Zealanders the breakdown was 16% genetic modification and 71% organic; and amongst farmers 15% genetic modification and 70% organic.[2:25]

Another recent report into the attitudes of New Zealand farmers and horticulturists towards GE technology and organic production methods found that 21% of farmers and growers were positive about using GE technologies, and 44% opposed; 37% were positive about using organic production methods, and 19% opposed. This study found that:

> …the majority of farmers and growers indicated a desire for New Zealand becoming gene technology free, and they clearly favour using organic methods. Against this, a smaller group expressed a desire to use gene technology… [This] has profound implications for New Zealand's science institutions, lobby groups and politicians. The evidence presented here suggests that some of these bodies have lost touch with the grassroots sentiments of the industry they purport to serve… Policymakers, scientists and industry planners need to factor in the possibility that should they adopt gene technology it may not be adopted by the majority of New Zealand farmers and growers.[2:26]

Many in the production sector assert that organic production and farming involving GMOs can co-exist side by side, seeking by this accommodating approach not to foreclose on future opportunities with GE technology. However, standards set by the International Federation of Organic Agriculture Movements (IFOAM) specify that organic production systems and GMOs are not compatible.[2:27]

In other areas New Zealand producer agencies such as the New Zealand Dairy Board are actively pursuing the potentials of genetic science to increase efficiency in farming and production processes, and to add value to products and commodities. Research

is being undertaken into possible development of genetically modified products intended to improve health (for example, by lowering levels of fat in animal products); other work is focused on specific niche medical technologies (for example, genetically modifying sheep or cattle to enable development of treatments for such diseases as cystic fibrosis and multiple sclerosis). In forestry, a range of GE projects are under way, including research into "designer trees" with particular characteristics.

There is increasing recognition that New Zealand's overseas markets expect "clean green" products. However, the strength of consumer opposition to GE foods in Europe and other countries has led to some concern within the production sector that New Zealand farmers might be prevented from making use of potentially powerful genetic techniques that could make valuable contributions to the future viability and competitiveness of their products.

Federated Farmers, an organisation with 16,000 members throughout New Zealand, considers that the majority of the farming sector would accept GE biocontrols if they were satisfied that any associated risks had been identified, assessed, and deemed acceptable. Choice - the ability to use the technology or not - will be critical for farmers in regard to new technologies such as GE biocontrols. At the Federated Farmers' national conference in 1997, a policy on GE was developed; the policy includes:

- support for the principle and application of gene technology within agriculture, providing appropriate controls exist;
- recognition that this technology can provide benefits to New Zealand producers, including the potential for higher yields, precisely determined product attributes, higher quality, and improved animal disease management tools;
- endorsement of individual farmers' rights to determine what technologies are used in their production system;
- support for regulatory frameworks to scientifically assess and manage risks to the health and safety of people and the environment; and
- encouragement of active risk communication by regulatory bodies and the supply of other information.[2:28]

2.6.6 The production sector and possums

The current economic impacts of possums on primary production are extensive.[2:29] The threats posed by possums as carriers of bovine tuberculosis (Tb) are also very significant for New Zealand's trading viability.

New Zealand is a member of the Office International des Epizooties (OIE), the world organisation for animal health. The OIE has established guidelines for the management of bovine Tb; the European Community also has recently updated standards. New Zealand's present systems under the Animal Health Board's National Pest Management Strategy for bovine Tb do not conform to the OIE guidelines; this entails a risk that other countries, particularly those where Tb has been eradicated, may impose non-tariff trade barriers against our exports. This has already occurred in two cases.[2:30] It has been estimated that the potential total cost of such possible targeted trade measures against New Zealand products (dairy, beef and venison) would total overall NZ$1.29 billion.[2:31]

There is also increasing risk to New Zealand exports from adverse consumer responses to the presence of Tb in our landscapes and in wildlife such as possums. The Animal Health Board draws attention to the risk of perceptions that New Zealand dairy and meat products might contain micro-organisms, noting rising concerns amongst discriminating European consumers for food safety and quality, and concluding that "the risk of widespread consumer rejection is a major concern".[2:32] Competition is intense, and has only been exacerbated by Australia's recent declaration of Tb-free status.

2.6.7 The biotechnology industry

Organisations involved in the biotechnology arena have recently come together in the New Zealand Life Sciences Network, an umbrella group advocating the responsible use of biotechnology, that is rapidly taking an active role in the GE debates. It was formed to co-ordinate the efforts of member organisations, share information, advocate for biotechnology, and play a public education and media relations role. It is concerned to ensure that New Zealand does not limit or constrain its options in regard to future use of

genetic science. The objectives of the Network include:

- promoting the economic opportunities of biotechnology;
- assisting member organisations to have input into policy on biotechnology research and development;
- influencing the advancement of responsible biotechnology research and development within an appropriate framework of regulatory controls based on scientific and risk management principles; and
- influencing public policy and the continued availability of biotechnology products and applications.

The Network has been active in co-ordinating input to IBAC and to the processes for the Royal Commission of Inquiry, and organising speakers and events to promote the benefits of genetic science and encourage rational debate on biotechnology.

Various industry groups including the food industry, production sector, medical and pharmaceutical sector, and research agencies have been involved in the GE debates promoting the particular benefits expected from genetic technology for their sector or, as with the NZ Grocery Marketers Association in regard to the development of food labelling standards, defending the position and interests of their sector. Some groups are working more proactively – for example, the Association for Crown Research Institutes has recently published a booklet, *The Place of Genetic Technology in New Zealand* (ACRI, July 2000), strongly supportive of GE: "genetic technology has a positive role to play in the nation's economic, social and environmental future".[2:33]

2.7 Tangata Whenua

The following discussion is offered as a contribution to advancing understanding on the matters that will be important for tangata whenua in relation to genetically engineered biocontrols for possums. This discussion does not have the status, nor should it be taken in place of, the statements of iwi, hapū and whanau on their own behalf on genetic engineering, on specific applications for GMOs, possum biocontrols, or any other issue.

2.7.1 Whakapapa

For tangata whenua, a new technology, such as the proposed GE biocontrols for possums, will be approached from the basis of whakapapa, the framework for all existence:

> Some wananga begin with Te Kore, the realm of chaos or nothingness, of potential being… from Te Kore arose Te Po, the night realm, and from thence the twilight dawn, then Te Ao Marama, the full light of day… from whence came Rangi and Papa…
>
> From these two primal parents arose many offspring, all supernatural beings, each responsible for, or guardians of, particular natural phenomena… Tane Mahuta, god of the standing forest… engaged in numerous procreation events with supernatural female deities… produc[ing] nine species of large trees. With Punga he produced the insects and other small creatures of the forest… Further cohabitations produced all the birds…
>
> Tangaroa was god of the sea and all sea creatures. All fishes are descended from one of his grandchildren, Ikatere, and reptiles from another, Tutewehiwehi… Rongomatane, god of agriculture, was responsible for all cultivated foods especially the kumara… Haumiatiketike was the god of the uncultivated foods, eg the bracken fern root.
>
> …eventually the gods moulded a human form from the red clay of Kurawaka at Hawaiki… Tane then breathed into its nostrils the Ha or breath of life…[2:34]

Within the structures of whakapapa, all the elements of the natural world are originally descended from Ranginui and Papatuanuku, the sky and the earth. All living things – trees and plants, fish, birds, insects, people – are connected back to the atua through whakapapa and are thus linked together in the bonds and obligations of kinship. This inter-dependence has, from the very beginnings of the living world, been the proper order established by the gods as the basis for the coherence and correct functioning of te putaiao, the natural environment. Modifying the genetic composition of living things is seen by many Maori as a disrespectful disruption of these relationships and their sacredness or tapu.

One consequence of the inter- relatedness between the land, the gods and the people is that what affects one part of this network will also have effects on other parts. Changes to natural resources, taonga species, or places of significance to tangata whenua – such as genetically modifying native plants or releasing a GE biocontrol into the environment – will often have a range of consequences. At the most immediate level there is the degradation or loss of taonga, and the interruption of the centuries-old relationships between people and the resources and ecosystems on which they and the living culture depend. But such disruption may also come through for iwi, hapū and whanau in specific cases of mate Maori, or patterns of disturbance or sickness;[2:35] effects may be inter-generational, passing on to future generations. Disturbances may be evident in broader spiritual and metaphysical effects within the whanau and hapū, the wider community, or the environment: "From… the mountains and rivers fundamental to tribal identity, to the manifestation of ancestors or spiritual presences in a bird, fish or lizard, all is interconnected".[2:36]

Therefore the responsibilities of kaitiaki are profound and far-reaching.

2.7.2 Tikanga

Tikanga Maori can be described as the correct way of doing things. Tikanga, as relating to the natural environment and resources, works from an understanding of such concepts and principles as mauri, kaitiakitanga, mana, rangatiratanga, and tapu.

Everything in the natural world, including people, all other creatures, forests and plants, rivers, resources and land, has its own mauri – the essential life force or distinctiveness that enables each thing to exist as itself. For the survival and well-being of each taonga, its mauri must be healthy and strong, respected, and protected if necessary. Mauri can be diminished or destroyed altogether when a resource is polluted, damaged or corrupted, or when its integrity has been breached or broken.

Some Maori have objected to genetic engineering on the basis that it interferes with the completeness of individual taonga, as well as disrupting the correct ordering of whakapapa established by the gods. This is particularly so when the genetic science proposes the transfer of genetic material across species boundaries, such as between animals and plants, or when human genetic material is involved. The principle is similar to the cultural and spiritual offensiveness of mixing waters from different sources or catchments, which has been at the heart of tangata whenua opposition to a number of proposals for water supply infrastructure. Maori have identified a range of specific risks from GE – for example, the potential risks to rongoa or traditional medicinal plants (to which increasing numbers of people are returning for natural healing in modern times), and the potency and effectiveness of remedies made from them.

Kaitiakitanga is the ongoing necessity for tangata whenua to look after the taonga, both physical and intangible, that are their heritage. The work of kaitiaki is a kete full of duties and obligations, an interweaving of tikanga, matauranga and practical sustainable management. There are the responsibilities of humans to te taiao, to the complex network of species and processes described by ecologists as "biodiversity" and "ecosystem health". There are responsibilities also to the continuum of past and future generations, to the ancestors, to present-day whanau, and to those who will follow and look back to us. Kaitiakitanga is not static, although it is firmly rooted in tradition – it is continually evolving and adapting to meet the demands of the 20th and 21st centuries, and to develop practical solutions for contemporary management challenges.

Tapu is another fundamental force, derived from the gods, and extending widely to many contexts and applications:

> The modern translation of tapu as "sacred" fails to capture the full essence of tapu. Elsdon Best, an early anthropologist, described tapu as the power that preserved order in the community, and took the place of civil law. Tapu implies a prohibition which if violated would have calamitous consequences; quite possibly, death… even though nothing is visible, a person who violates [tapu] knows the awful and inescapable consequences which will certainly follow.[2:37]

Rangatiratanga, confirmed and guaranteed under Article II of the Treaty of Waitangi, and mana are critical principles for the effective functioning of the Maori world.

Rangatiratanga is often described as self-management, the right of iwi, hapū and whanau to make their own choices about things that concern them, "the right to have interests and to make decisions, in terms of the [taonga]".[2:38] Mana is closely linked with the practical expression of rangatiratanga. Mana is, like mauri, a gift from the gods – the power, prestige and authority which enables the necessary work to be done for the satisfactory fulfilment of kaitiaki responsibilities.

2.7.3 Te Tiriti o Waitangi – the Treaty of Waitangi

The Treaty of Waitangi 1840 is the founding document of New Zealand as a nation. It records the fundamental bargain between the Crown and Maori, seen in the relationship between the provisions of Article I and those of Article II of the Treaty – the exchange of the right of the Crown to govern, in return for confirmation of the rangatiratanga of tangata whenua, and the obligation to protect Maori interests. The Treaty did not convey any special rights to tangata whenua – by the Treaty, the Crown confirmed and guaranteed their existing rights to land and natural resources, including rights in respect of intangible taonga. The Treaty has affinities with the Common Law doctrine of aboriginal title.

It is generally accepted that our understanding of the Treaty of Waitangi, and its implications for contemporary management of natural taonga and resources, is continually evolving. There is a constantly expanding body of case law and legal interpretation from the decisions of the Courts on a range of environmental cases under the RMA and other statutes.[2:39] The Waitangi Tribunal was established in 1975 to inquire into and make recommendations in respect of claims relating to the principles of the Treaty; many of the Tribunal reports provide valuable interpretation on a wide range of matters including specific recommendations for environmental management.

Some of the Treaty principles, as established by the Courts and discussed by the Tribunal, that will be relevant for the issues of genetic engineering in the New Zealand environment include:

- partnership between the Crown and tangata whenua, to act in good faith and to accord each other reasonable co-operation on major issues of common concern;
- active protection of the Maori interest in natural resources, species, places and other taonga, which will involve more than passive recognition or consultation with tangata whenua;
- management of natural resources, species, places and other taonga according to tikanga; and
- recognition that taonga include both tangible and intangible dimensions and values.

One claim currently being heard by the Tribunal is the "indigenous flora and fauna claim", commonly referred to as WAI 262 (its number in the Tribunal recording system). WAI 262 is a wide-ranging claim from six iwi in regard to the management, use, commercialisation, export and patenting of native plants and animals, of the genetic resources inherent within those taonga, and the whakapapa, intellectual property and traditional knowledge associated with them. This claim has direct relevance for any prospective technology involving genetic engineering of native species, or any proposal to release a GMO into the environment, such as some of the options for a delivery system for possum biocontrols. The Tribunal has been conducting hearings on the WAI 262 claim since 1997 and, given the complexity and sensitivity of the issues involved, and the Tribunal's resourcing constraints, it is expected the process will take some years yet.

2.7.4 Statutory provisions

Statutory references to the Treaty of Waitangi, and to obligations of the Crown and official decision-makers to consult with tangata whenua, are generally only features of legislation passed within the last 15 years. The legislation that provides the framework for possum control is no exception. Earlier legislation such as the Wild Animal Control Act or the Pesticides Act does not contain any reference to the Treaty or obligations under it. Even some of the more recent legislation, such as the Agricultural Compounds and Veterinary Medicines Act 1997, does not contain any such references. However, the main pieces of legislation in this area do contain statutory references to the Treaty and to obligations to consult with tangata whenua:

Conservation Act 1987:
Section 4: This Act shall so be interpreted and administered as to give effect to the principles of the Treaty of Waitangi.

Resource Management Act 1991:
Section 6: In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance… (e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.
Section 7: In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to… (a) kaitiakitanga.
Section 8: In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).
Sections 61(1), 66(1) and 74(1), and the First Schedule, establish specific requirements for consultation for the preparation of regional policy statements and plans and district plans.

Hazardous Substances and New Organisms Act 1996:
Section 6: All persons exercising functions, powers, and duties under this Act shall, to achieve the purpose of this Act, take into account the following matters… (d) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, valued flora and fauna, and other taonga.
Section 8: All persons exercising powers and functions under this Act shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).
Section 73(1): During the preparation of a proposed regional pest management strategy, a regional council shall consult… (c) the tangata whenua of the area who may be [affected by the strategy], through iwi authorities and tribal runanga.

2.7.5 Iwi policies

Some iwi have established formal policy on genetic science and its use in their rohe. Two examples are included to indicate the kinds of positions that are being taken.

Te Runanga o Ngai Tahu discussed genetic modification at a series of iwi hui, and in September 1999 confirmed a previous interim policy that:

> Te Runanga o Ngai Tahu opposes the release of any genetically modified organism into the environment.
>
> Te Runanga o Ngai Tahu opposes the granting of any application for the development of genetically modified organisms. This opposition will continue until Te Runanga has concluded the impact such genetic modifications will have upon critical social and cultural concerns related to Whakapapa, Kaitiakitanga and Rangatiratanga are addressed to its satisfaction.[2:40]

Te Runanga o Raukawa, in its Iwi Management Plan for the Otaki River and Catchments, includes an objective "to ensure that the Otaki River is maintained as a genetic engineering free zone". Policies are established opposing the use of genetic engineering (including research, trialling and testing of genetically modified organisms) within the Otaki district, and supporting organic farming and permaculture approaches to agricultural, aquaculture, agroforestry and horticultural land use in the rohe. Ngati Raukawa considers there to be "distinct economic advantages in maintaining New Zealand as a genetically modified-free environment and that these outweigh any short-term material benefit of allowing GE". The Runanga notes that requests for exemption to this policy will be considered if it can be "specifically demonstrated [that the technology will] produce a net long-term environmental benefit to the well-being of the Otaki River and its communities", and mentions as a possible example "genetic modification for possum or similar pest control where no other viable control exists".[2:41]

Some spokespersons for iwi or hapū have made statements supportive of GE and of biotechnology enterprises; iwi representatives have been working with the research agencies developing these technologies, as advisers or facilitators of consultation processes. Some iwi and hapū have become involved with these issues in the process of making submissions to ERMA in

response to applications for particular new organisms to be trialled – for example, the proposal for a herd of GM cattle incorporating human genes, formally opposed by Te Kotuku Whenua for Ngati Wairere (see 2.6.4). Tangata whenua are also increasingly involved in organic farming and horticulture, with initiatives such as the Taitokerau Organic Producers group, or the East Coast Organic Producers Trust based in Ruatoria, and are thus directly concerned with the potential effects of GMOs in relation to this work and their production and economic development objectives.

2.8 Ethical Frameworks

Whilst technology, in the form of genetic engineering, may make the control of possums in New Zealand possible, it is the social, political and cultural context that will determine if the use of this technology is acceptable. As people living in a sophisticated civilised society at the turn of the 21st century, we share a common morality: the freedom to make our own choices, being fair, not causing unnecessary harm, and generally doing good. In considering whether genetically engineered methods of controlling possums are acceptable, people will be considering their positions on this issue from some place within this general morality.

Current approaches and the outcomes desired from biocontrol techniques aim to reduce possum numbers. This raises the overarching ethical question – is it right to kill possums or reduce their fertility? A commonly held view in our society is that it is appropriate to kill animals provided that it is justified and undertaken humanely. In New Zealand we kill animals for, amongst other things, food, clothing, sport, and pest control. There are many variables that influence how humane or justified we think a certain approach is – in relation to biocontrols, for example, does the method target the young or old, and is death swift or prolonged?

The ethical questions can be broadly divided into two categories. First are concerns about whether GE is right or wrong in or of itself, regardless of the potential consequences. Second are those questions that concern the wider consequences of the use of GE technology on the environment, animal welfare, human heath and safety, human cultures, and our economy and society.

Issues coming to light with reference to GE include the view that nature is sacred, and that GE interferes with nature and is therefore unethical or immoral. Closely related to this is the view that genetic engineering unacceptably violates species boundaries and genetic integrity, mixing DNA from diverse creatures and plants that do not in the course of nature exchange gene material. In essence these arguments centre on the premise that humans do not have the right to manipulate nature in ways that do not occur naturally. To many people, genetic engineering is disrespectful to and disruptive of the sacredness of life and the environment:

> Developments in Western science, from about the 17th century on, have been accompanied by the 'demoralisation' of nature. Nature became something to be used, controlled, subdued… Nature became more of a 'thing', the 'other' that we exploit as we wish… Biotechnology is a logical extension of this, with our ability to understand and manipulate 'nature' extending to the molecular level. That which was immutable or 'given' we now can transform and rearrange. That which was beyond our control, we can now mould in almost any direction we care to imagine… All of life, human and non-human, could be subject to manipulation.[2:42]

Countering these kinds of perspectives are arguments put forward to justify GE, including such concepts as:

- to be human is to be a part of nature and GE is just another human development;
- species boundaries are crossed using more traditional means (the mule is a cross between a horse and a donkey); and
- natural things can also have terrible consequences (for example, cholera).

These considerations are critical for 21st century society to determine the sort of people or community we want to be, now and into the future, and the cultural ideals we want for ourselves and our relationship with the natural world we inhabit. What impacts would the acceptance of genetic engineering and the biocontrol of possums have on these ideals?

Specific considerations that are relevant from an ethical perspective in relation to the wider consequences of implementing biocontrols include:

- Animal welfare: essentially the purpose of pest control methods is to cause harm to the animal resulting in death, impaired fertility or other effects. Ethical consideration must be given to the extent of suffering endured by the animal.
- Environment: There is moral weight to the argument that those in research and development have a responsibility to consider the risks of unintended consequences of technology and make their findings available to the wider community. What responsibilities do we have to other species and nature in general? Is there a risk to non target animals and species? What impacts might the new technology have on the food chain? Is mutation that could lead to new pests, or increased virulence of present pest species, possible?
- Socio-cultural: Considerations include a range of inter relating questions. Who benefits from using biocontrols in possums and who carries the risk? Who will be liable for unforeseen and harmful consequences? Who decides which biocontrols are acceptable? Some individuals, businesses and communities may benefit from the opportunities of genetic engineering, while others may suffer, or object on the grounds of values and beliefs. How will GE impact on the values, culture and traditions of tangata whenua? What does genetic manipulation mean for the spiritual dimensions of nature? And questions of power are inherent in many dimensions of these issues – the power to modify life on earth into shapes and forms not currently in existence; the power of different cultures asserting their ideals and their ways of looking at the world; the power of multi-national corporations to influence global environments; and the power of ordinary people to determine what kind of world they want for their children, and future generations.

(See Appendix B: The development and use of innovative technologies for the control of possums in New Zealand – an introduction to the ethical implications.)

2.9 Legal and Regulatory Frameworks

The legal and regulatory frameworks for possum control in New Zealand can be looked at on three levels:

- What allows possums to be subjected to some kind of control?
- What agencies co-ordinate the control regime?
- How is control of possums implemented "on the ground"?

There is also the question of how *new* methods of possum control, such as a biocontrol, are introduced into the legal and regulatory framework.

2.9.1 What makes possums subject to control?

It is well known that possums are a "pest" and that efforts need to be made to control them. However, under the New Zealand constitutional system, such definitions and descriptions must be specifically put into statute by Parliament to have legal force. Possums are put in the pest category by the Wild Animal Control Act 1949, where they are defined as "wild animals" and are therefore subject to "control" or eradication if practicable. The Biosecurity Act 1993 includes among its provisions the development and implementation of pest management strategies (discussed below). In a somewhat circular definition, a "pest" is defined as any organism that has been specified as a pest in such a pest management strategy. Possums are classified as pests under this regime.

2.9.2 Which agencies co-ordinate control?

The agency responsible for the management of "control" under the Wild Animal Control Act is the Department of Conservation (DOC); it has responsibilities on both privately-owned and Crown land, including what is generally known as "the conservation estate". Control work is to be directed through statements of general policy, wild animal control plans and conservation management strategies.

The organisational complexity of possum research and management was highlighted in the PCE's 1994 report. Figure 1 details the agencies currently involved in possum control, research and liaison structures. While still complex, current arrangements have been strengthened by additional co-ordinating groups in particular the Biosecurity Council and the Pest Management Strategy Advisory Committee.

Under the Biosecurity Act, the Ministry of Agriculture and Forestry (MAF) and regional councils are the main agencies with responsibility for possum control. This Act provides for the preparation and implementation of both national and regional pest management strategies. All regional councils have implemented regional pest management strategies. These strategies go through a preparation process involving extensive consultation and hearings, and must specify a management agency (generally the regional council) and an operational plan by which that agency will implement the strategy.

The Animal Health Board has a National Pest Management Strategy for Bovine Tuberculosis that involves substantial possum control. However, there is not a national strategy in place for possum control. MAF is currently compiling a report on the idea of a national possum strategy, but notes there may be difficulties due to the different objectives of various stakeholders in pest management.

The National Possum Control Agency (NPCA) is an inter-agency forum that was established in 1994 to co-ordinate operational aspects of possum control. Recently the focus has been on quality assurance, training, accreditation of monitoring personnel, technology transfer, and production of resources for public awareness and education.

Although there are these extensive efforts to co-ordinate possum research and control efforts there is, as yet, no single possum management strategy. In a 1998 PCE review[2:43] of the PCE's 1994 possum management recommendations, it was argued that there was merit in incorporating the various objectives of possum control into a single national strategy. Control agencies rejected the idea of a national strategy early in 1998. They have consistently argued that possum management objectives for vector control and conservation are so different that a single strategy would serve little purpose. No coherent argument for or against a single strategy has been tabled by any government policy agency or industry group. However, MAF has recently (early 2000) done some analysis of the issues and a draft paper is understood to be being debated within the organisation.

2.9.3 How is control of possums implemented "on the ground"?

The basic method of control referred to in the Wild Animal Control Act is hunting (both recreational and commercial). This Act specifically authorises the hunting and killing of possums, and restricts the keeping in captivity and releasing of wild animals as a control mechanism.

The methods involved in respect of a pest management strategy under the Biosecurity Act will depend on the strategy and its operational plan. Hunting or the use of 1080 poison are amongst the methods adopted.

The use of a substance such as 1080 poison was governed by the Pesticides Act 1979 until the Hazardous Substances and New Organisms Act 1996 (HSNO Act). The parts of this Act for Hazardous Substances are not yet in force; therefore the use of 1080 still comes under the control of the Pesticides Act in the meantime. The Pesticides Act 1979 controlled the use of "pesticides", which were defined as substances that were represented by their sellers as suitable for controlling or eradicating pests. Certain pesticides (including 1080) were listed as "controlled pesticides", the use of which was restricted. These restrictions were implemented through the Pesticides (Vertebrate Pest Control) Regulations 1983 (VPC Regs). The VPC Regs provide for a two-tier system involving the licensing of people who use controlled pesticides such as 1080, and an approval regime for any pest control campaign using controlled pesticides in certain areas, including places to which the public has access, buffer zones, and areas near population centres and catchments where water is drawn for human consumption.

While there is a list of authorities whose permission is required before a controlled pesticide can be used in a restricted area, for the purposes of possum control using 1080 under the Biosecurity Act, permission is needed mainly from the Medical Officer of Health (MOH) for the relevant area. The MOH gains his or her powers and responsibilities under the Health Act 1956 and, in considering whether to grant permission under the VPC Regs, is specifically directed to the Health Act's provisions. Those provisions are limited to effects on human health and do not involve any effects on other organisms.

Figure 1: Agencies, and their inter-relationships, involved in possum control, research and liaison structures

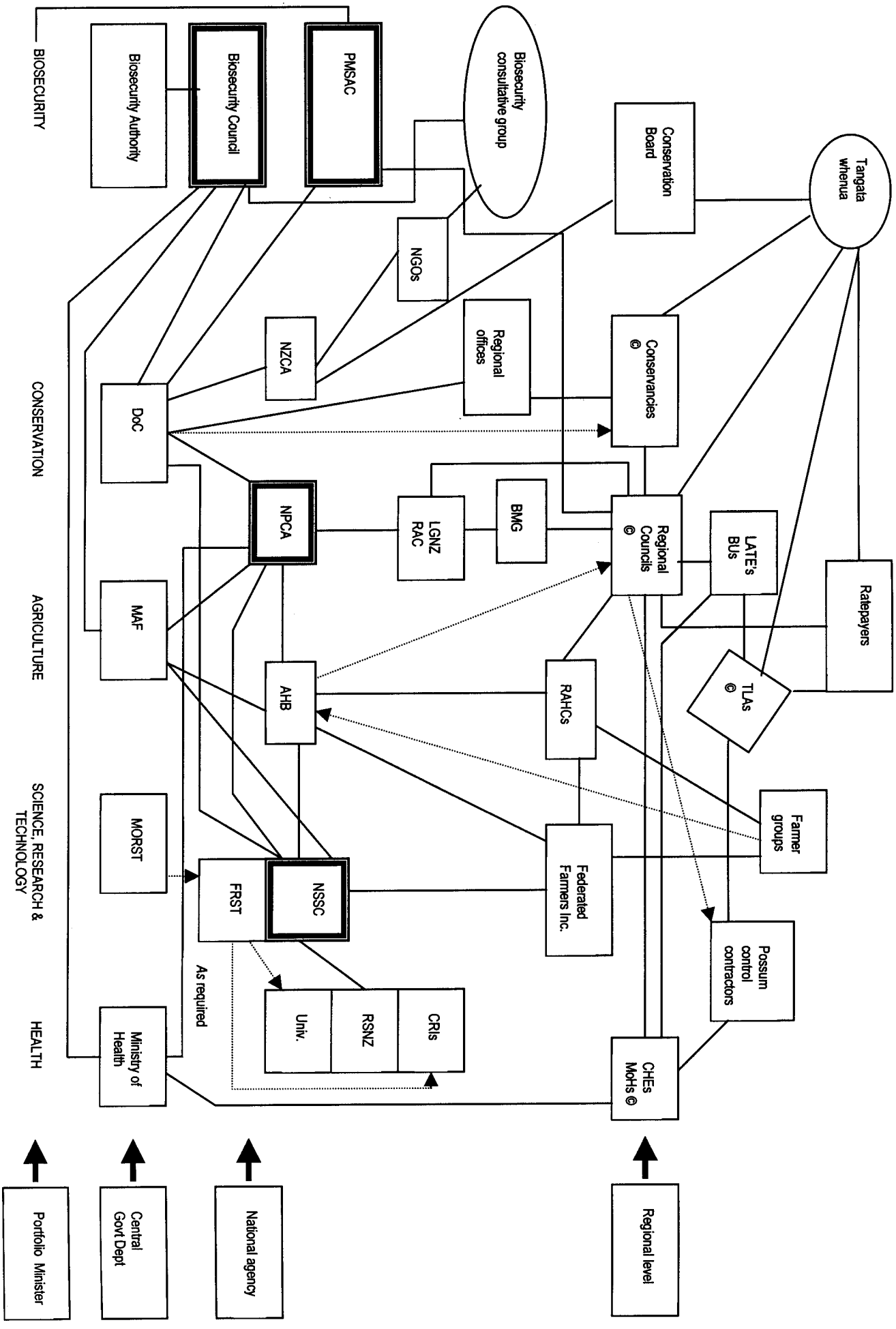

Figure 1 : Key
Agencies, and their inter-relationships, involved in possum control, research and liaison structures

Co-ordinating role

© Authority providing consents for possum control

Funding flows

Primary "connections" between agencies and/or committees.

PMSAC	Pest Management Strategy Advisory Committee
BMG	Biosecurity Managers Group
NZCA	NZ Conservation Authority
NPCA	National Possum Control Agency
AHB	Animal Health Board
NSSC	National Sciences Strategy Committee (possums/Tb)
LGNZ, RAC	Local Government NZ, Regional Advisory Committees
RAHCs	Regional Animal Health Committees
FRST	Foundation for Research, Science and Technology
RSNZ	Royal Society of NZ
CRIs	Crown Research Institutes

While the HSNO Act will repeal the Pesticides Act, the VPC Regs remain in force under the transitional provisions of the HSNO Act. A new regime will need to be in place before the transitional provisions expire; ERMA advises that the transitional provisions will continue into 2001. The HSNO Act, while controlling the introduction of *new* hazardous substances and organisms, does not (apart from the transitional provisions) presently provide for any control once a hazardous substance or organism has been approved and "released" (the present restrictions on the use of "controlled pesticides" would, for instance, seem to disappear).

A part of the new regime will be the Agricultural Compounds and Veterinary Medicines Act 1997 (ACVM Act) discussed in greater detail below, administered by MAF. This Act was passed in 1997 to be brought into effect by Order in Council. No such Order in Council appears to have been promulgated to date. The ACVM Act provides for continued control of pesticides in the sense of restricting their sale and use generally, but does not appear to have any equivalent to the VPC Regs.

2.9.4 The Animal Welfare Act 1999

One of the purposes of the Animal Welfare Act is to ensure that animals are treated in an appropriate and humane way. This Act also provides for criminal sanctions in the case of breaches. In theory, a possum control method could breach this Act. However, there are two explicit exceptions to the Act's provisions:

- hunting and killing "wild animals" (which includes possums); and
- the use of agricultural compounds registered and used under the ACVM Act or hazardous substances approved and used under the HSNO Act.

So long as the present control methods such as 1080 continue to be authorised under the ACVM and HSNO Acts, and new methods are similarly authorised, the Animal Welfare Act will not affect their use.

2.9.5 Introduction of new controls, including biocontrols

New controls on possums will need approval before they are introduced. How that approval is obtained, and from whom, will depend on what the control is. The relevant

statutes are the HSNO Act (where the decision-making body is the Environmental Risk Management Authority) and the ACVM Act, where the Director-General of Agriculture will be the decision-maker. Proposed biocontrols would be assessed under the HSNO Act.

It appears that authorisation under both the HSNO Act and the ACVM Act will be necessary for a new biocontrol for possums such as the methods currently being researched. ERMA advises that it is intended that there will be a two-tier process for considering applications for such organisms. This would involve authorisation under the HSNO Act, and then, only after that authority has been obtained, registration under the ACVM Act. ERMA notes that it anticipates both applications would be filed at the same time so that the time delay between the two approvals is kept to a minimum.

2.9.6 The Hazardous Substances and New Organisms Act 1996

The HSNO Act controls the introduction of hazardous substances and new organisms to New Zealand. The definition of hazardous substance includes substances that are "ecotoxic" (defined as capable of causing ill health, injury or death to any living organism). Any possum control that is a substance (defined to include almost anything that is not an organism) would be a hazardous substance.

The definition of "new organism" (defined as including genetically modified organisms) relies on the definition of "organism". This definition excludes humans, but includes micro-organisms and genetic structures capable of replicating themselves. It also includes anything declared to be an organism for the purposes of the Biosecurity Act. Several potential biocontrols for possums are likely to come within this definition.

The HSNO Act established an integrated process for consideration and approval of the importation, manufacture, release and control of hazardous substances and new organisms in New Zealand. It requires assessment of the effects of a new organism or hazardous substance on the health and safety of people and on the environment, before it may be introduced. Most assessments are conducted through a public process to ensure that all relevant information is considered.

The Hazardous Substances and New Organisms (Methodology) Order 1998 (SR 1998/217) sets out the methodology to be adopted by ERMA when making decisions under the HSNO Act. The procedure is prescribed in detail and includes public notification of applications, a submissions process, and public hearings to be held if ERMA thinks it is necessary, or either the applicant or a submitter requires. Decisions can be appealed to the High Court but only on "a point of law".

2.9.7 The Agricultural Compounds and Veterinary Medicines Act 1997

The ACVM Act will control "agricultural compounds". The definition of agricultural compounds specifically refers to such compounds that are used to manage or eradicate pests including possums. The definition is further expanded to cover "biological compounds" which includes animals, viruses and other micro-organisms. Most possum biocontrols would be covered within this definition in some way.

It is noteworthy that the definitions in the HSNO Act and the ACVM Act, are not identical, which may create some confusion.

Under the ACVM Act the process will involve an application for "registration" which is made to the Director-General of Agriculture. The process includes notification to relevant official agencies, public notification, and a submissions process, although there appears to be no requirement to hold a hearing. In making the decision the Director-General must weigh up certain risks and benefits:

- risks to trade and market access for primary products;
- risks to agricultural security;
- risks to the welfare of animals;
- risks to domestic food residue standards;
- benefits of the use of the product and the consequences of it not being available including whether the same end can be achieved by other means.

The Director-General cannot approve a substance that contains a hazardous substance or new organism unless that substance has been approved under the HSNO Act. Appeals from decisions of the Director-General can be made to the High Court but only on "a point of law".

2:1 K Hackwell and G Bertram 1999: *Pests and Weeds: The cost of restoring an indigenous dawn chorus: A blueprint for action against the impacts of introduced pest organisms on the New Zealand environment*. New Zealand Conservation Authority, p 61.

2:2 Parliamentary Library. *Possum Control*. Information Briefing Service, 15 February 2000.

2:3 NSSC. *Possum and Bovine Tb Management in 2010*. Workshop 28-29 August 2000. Papers by Phil Cowan, Janine Duckworth, Lynne Selwood and Shuliang Cui, Doug Eckery, Jerome Demmer, Bernie McLeod *et al*, Geoff de Lisle, John Rodger.

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2:6 Editorial, *New Scientist*, 27 May 2000.

2:7 Watson, p 21.

2:8 www.planetark.org/dailynewsstory.cfm?newsid=6869, 26 May 2000 and =7064, 12 June 2000.

2:9 Genes jump species barrier. *The Dominion*, 29 May 2000; www.planetark.org/dailynewsstory.cfm?newsid=6903, 31 May 2000.

2:10 Economic and Social Research Council (ESRC) 1999. Global Environmental Change Programme. *The politics of GM food: Risk, science and public trust*. www.susx.ac.uk/Units/gec/gecko/gm-brief.htm, p 8.

2:11 Is Monsanto's Biotech Worth Less than a Hill of Beans? *Fortune*, 21 February 2000, 87-89.

2:12 www.biotech-info.net/Deutsche.html; www.the-times.co.uk/news/pages/sti/2000/05/21/stirevnws02001.html; Tales of the Tape: Seed Co. May Yet Reap What They Sow. *Wall Street Journal*, 7 January 2000.

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2:14 For example: EU keeps moratorium on new GM crops. www.planetark.org/dailynewsstory.cfm?newsid=5935, 10 March 2000; Three Italian regions ban GM crops. www.planetark.org/dailynewsstory.cfm?newsid=6730, 18 May 2000; The Welsh assembly has put itself on a collision course with the British government over genetically modified crops by voting unanimously for a ban throughout Wales. *Dominion*, 26 May 2000, p 5; Brazil officially bans genetically modified crops. www.planetark.org/dailynewsstory.cfm?newsid=7067, 12 June 2000.

2:15 HRH Prince of Wales, Reith Lecture, May 2000. http://news.bbc.co.uk/hi/english/static/events/reith_2000/lecture6.stm

2:16 SAFE pamphlet. *ANIMALS have a right to be GE FREE.*

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3. FINDINGS

3.1 Introduction

This chapter outlines the range of responses, views and concerns identified in the consultation, interviews and other research for this investigation. This information includes matters raised in the focus group discussions, matters raised in the other consultation and interviews undertaken by the PCE investigation team, and material gathered from the literature and the internet. A separate report on the focus group process is provided at Appendix A. These various kinds and levels of information share many common concerns and patterns; therefore, a thematic approach has been taken in ordering this chapter, bringing together relevant points from the respective sources.

The statements given in italics in the following sections are taken from the separate report of the focus group process (Appendix A), and from notes taken during the PCE's other consultation and interviews for this investigation. They are included to give a direct reflection of the kinds of concerns raised by project participants. The letter codes given after the quotations from Appendix A follow that report's identification of the focus groups:

- Women members of the public, Te Atatu – Women, W
- Men members of the public, Birkdale – Men, M
- Provincial members of the public, Levin – Provincial, P
- Scientists and health professionals – Scientists, S
- People with ethical interests – Ethics, E
- Industry practitioners – Industry, N
- Opponents of genetic engineering – Opponents, O
- People with conservation or environmental interests – Environmentalists, C
- South Island iwi group – Iwi, I.

3.2 The Possum Problem

Most of the focus groups and many of the other discussions undertaken by the PCE began with consideration of the possum problem and the pros and cons of the existing management regime. The information pamphlet provided as the basis for all discussions (Appendix C) included a brief overview of some of the issues surrounding possum management in New Zealand.

The social science researchers working with the project team had expected, on the basis of previous research into public attitudes towards pest management, that amongst the New Zealand public there would be a general acceptance that possums are a problem requiring urgent action. While most people agreed with this basic premise, there was uncertainty amongst some people about the extent and severity of the problem, and the most appropriate ways of dealing with possums. Some participants in the focus groups had little awareness of the scale of possum infestation, the scientific evidence for the extent and implications of possum damage, the adequacies of current control methods, and the practical complexities of pest management work. The PCE's other consultation with pest control experts revealed the actual necessities involved – project and contract management requirements, equipment, staffing, training (possum handling, 4WD, bush skills, etc), the logistics of running pest control teams, co-ordinating the retrieval of possum fur, and consultation with landowners and neighbours. The most fundamental realities of possum control work and fur recovery were made clear at the Mangamuka hui, with the reminder of just how heavy a load of six dead possums gets when carrying them for several hours through difficult bush terrain.

There was, however, a broad awareness amongst the focus groups, and others consulted for this investigation, that possums are not the only threat to New Zealand's biodiversity. Possums were described as *just another introduced species* (E), along with deer, stoats, weasels, goats and invasive weeds. There was agreement that the "possum problem" should not be considered in isolation but as part of the wider context of an *integrated conservation effort* (E). The focus group comprising people from environmental and conservation organisations was particularly emphatic on these issues, noting that ecosystems and their sustaining processes are complex, inter-connected, and often fragile – effectiveness of any control mechanism will require a holistic, integrated approach to pest management.

The risk posed by possums through the spread of bovine tuberculosis (Tb) was recognised as another issue for New Zealand, but amongst the focus groups this aspect was seen mainly as an issue of sectoral importance, a concern for farming communities and the relevant pest management authorities. This was paralleled in the consultation with farmers and regional council personnel, where there was a high consciousness of the importance of dealing with possums and the Tb threat, in order to protect New Zealand's exports and primary production sectors. There was a sense, both amongst some in the focus groups and in the Wairarapa farmers' group, of a distinction between Tb as a reason for controlling possums as compared to conservation imperatives – t*o the public, biodiversity is the bigger issue* (N). In one focus group, concerns were raised that the existing management system prioritised the control of Tb over the protection of native flora and fauna – *the government is only worried about Tb and bush next to farmland* (P). However, the perception amongst the Wairarapa farmers' group was that the general public has little appreciation of the implications and severity of bovine tuberculosis, and will be convinced of the need to control possums only by appeals to conservation of native forests and wildlife.

Box 4: Motatau Possum Control

At Motatau forest in the Taitokerau, pest control is serious business.

In 1996, Te Runanga o Ngatihine began the "Kaitiakitanga o te Kuku" restoration programme in conjunction with Landcare Research and DOC. The project focus is the kukupa (kereru or wood pigeon), an important taonga of Taitokerau that has been in steep decline due to habitat loss and predation.

The project began with the identification of kukupa nests in the Motatau forest; video cameras were set up for 24-hour nest monitoring. They recorded depressing but inarguable evidence of possums raiding nests and eating kukupa eggs (the kukupa lays only one egg at a time). All the nests monitored that first year failed due to predation.

At the same time, Ngatihine tackled the hard work of establishing a grid of bait stations on navigation lines through the forest. For three weeks in spring 1997 prefeeding was done at the bait stations, readying the possums for a blitz of 1080 in the fourth week; this was followed by ongoing control using brodifacoum. The trap catch rate dropped from around 25.6% before the blitz, to around 11.7%. Over the same time period, an uncontrolled comparison block, Okaroro, had a rise in trap catch rate from 32.6% to 60.8%. At Motatau, nest monitoring and intensive trapping continued; over the 1997-98 season, kukupa chicks were hatching, but before they could fledge, they were still being predated.

Ngatihine realised that Motatau was getting an ongoing influx of possums reinvading from surrounding land blocks. They called a meeting of the neighbours and got agreement for the possum control work to be extended to their properties, creating a buffer zone of at least 1 kilometre around the Motatau block. By September 1999 the trap catch rate had fallen to 2.7%, while the rate at Okaroro was 43%. A later survey carried out by Ngatihine resulted in a zero trap catch rate of possums at Motatau. And over the 1998-99 season, of the seven kukupa nests monitored, all fledged successfully.

The benefits include "seeing the forest health recover, increasing the bird life, seeing an improvement in the water quality, and working with positive thinkers and enthusiasts". Strategic utilisation of conventional possum control methods, intensively employed within a specific area, planned and managed by the local community, has shown that exciting results can be delivered in a very short time: "The big difference is that there is tangible evidence of 'kua hoki mai te mauri o te ngahere' – the life of the forest has returned".*

* Kevin Prime, presentation to the Hui Wananga: He Minenga Whakatu Hua o Te Ao, Murihiku Marae, 25-27 August 2000.

Many of the people in the focus groups and other consultation expressed the view that possums should be eradicated - *get rid of them totally, aim for zero numbers* (W). However, there was broad acceptance that this might well be an impossible goal, and that the best New Zealand would be able to do would be to bring possum numbers down to levels where their impacts were minimal or acceptable. There were also concerns expressed that eradication or control should not be seen as an end in itself; there was unease amongst some focus group participants that possums were being demonised, and that New Zealand environmental management was at risk of being dominated by a "killing culture". It was felt that killing possums should be justified as contributing to a higher purpose or goal – *not a negative approach but a positive approach, to create a habitat and focus on the birds coming back, rather than focus on killing* (C).

3.2.1 The possum fur industry

Despite general agreement that possums are a pest and should be dealt with, there was also recognition amongst nearly all the focus groups and in the Mangamuka hui that possums also represent economic opportunity in the form of a fur industry. There was also some mention of the potentials of using possum meat, if the Tb risks were resolved.

The strong support amongst some focus group participants and at Mangamuka for the opportunities in possum fur was linked with the principle of local people taking charge of environmental management in their local area. Some of the opposition to technology-based methods such as biocontrols, GE or aerial poisoning was based in the perception that these methods were imposed on local communities by remote government agencies. It was argued that local management would be more effective because local communities had the necessary knowledge of forests and landscapes to develop appropriate pest management programmes, the commitment to carry through the practical requirements, and a right to benefit from utilisable resources in the local environment. The Mangamuka hui strongly supported generating local employment from possum trapping and fur processing, while at the same time expressing the desire that possums be eradicated from their forests in the long term.
However, focus group participants and interviewees working in pest management were more sceptical about the practicalities of utilising possums in these ways, and about the effectiveness of such programmes for achieving significant reductions in possum numbers and protecting biodiversity. There was acknowledgement that encouraging utilisation of possums as a resource would foster an undesirable perception of value, and that if the possum fur industry were developed, people would want to retain a proportion of the possum population in order to sustain income, regardless of the damage that possums cause to conservation values. It was also suggested that only possums in the most easily accessible areas would be targeted. At the time of the PCE's investigation there had been some media attention to proposals, supported by Deputy Prime Minister Jim Anderton, to encourage a possum fur industry. The viability and desirability of this type of initiative were widely debated throughout the investigation. (See Box 2: A New Zealand Fur Industry – A Possumable Dream?)

3.2.2 The possum control "tool box"

There was considerable acceptance amongst the public focus groups and some other interviewees that New Zealand's existing possum control "tool box" is of only limited effectiveness. However, a significant number of participants, some with direct practical experience of possum management, were more confident of the kinds of results that could be achieved with present methods. Limitations were perceived to be either a function of the enormity of the possum problem or the prohibitive costs of large-scale eradication projects - *we're not really winning the war* (M); *we'll never eradicate any pests using our current methods* (C).

Sodium monofluoroacetate (1080) was the most hotly debated element of the present management regime. The perceived dangers of 1080, and the effects it is believed to have on the environment, were raised as the basis for its condemnation as a management tool by many people in the focus groups and in the Mangamuka hui. The issues discussed included the belief that 1080 affected water supplies, effects on dogs and livestock, and impacts on native birds, other wildlife, and the wider environment. The possibility that New Zealand's high levels of 1080 use could tarnish its international reputation was also mentioned – *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). However, some people with direct experience of 1080 projects in Northland and in the Central North Island spoke in favour of this method as a currently available tool, citing the positive results for forests, native bird populations and other wildlife after 1080 treatment.

Few groups discussed any other poisons besides 1080, although there was some awareness of the issues with secondary poisoning from the use of brodifacoum, which had recently featured in the media. Shooting and trapping were discussed mainly in the context of a potential fur industry.

3.3 Biocontrols

A common topic of discussion amongst the focus groups and others consulted for this investigation was the history of exotic species and organisms that have already been introduced into New Zealand. Many people noted that possums themselves had multiplied and spread devastatingly since they were brought in; other problem species mentioned included rabbits, gorse and deer. The Mangamuka hui raised major concerns about the introduction by Pakeha of alien species and diseases that had had devastating effects on the natural environment, on the resources upon which local communities depended, and on the people themselves. There was widespread consciousness amongst the focus groups, pest managers and Wairarapa farmers of the unauthorised importation of RCD from Australia, and of the fact that this control organism had in some areas turned out to be less effective on rabbit populations than had been anticipated. However, there was little awareness of any other specific biocontrol agents used in New Zealand or whether these had been effective. The general feeling was that the unintended consequences of such introductions of new species and organisms have already given ample evidence of the need for caution -*there are dozens of examples of things we have introduced with good intentions and they have backfired on us* (M).

The experience to date of the use of biocontrols in New Zealand took several of the focus groups back to the recognition that a diverse set of management tools is required, and that possums and other pest species require an integrated pest management approach. In the Wairarapa meeting there was discussion of the potentials of combining different methods – for example, using 1080 to achieve a major "knock-down" of possum numbers, then introducing a fertility-targeted biocontrol to maximise the reduction in the population in that area. To some people in the focus groups, the eventual inclusion of biocontrols in the possum management toolbox seemed to be an inevitability - *possums do so much damage we need to investigate as many options as possible* (C).

There was some scepticism about biocontrol options given the time horizons of research and application - *how far away is biocontrol? we need something fast-track* (I); *biocontrols are slow, no overnight success* (M). The group of Wairarapa farmers were particularly conscious of the timeframes involved in developing these new techniques, noting that for the rural sector as well as for conservation, dealing with possums is a present, urgent and ongoing imperative.

In addition to general concerns regarding biocontrols, the focus groups and other consultation drew out a range of responses to the specific biocontrol techniques currently being researched, as outlined in the information pamphlet (Appendix C). There was notable consistency in the responses and assessments of acceptability of the various techniques across all the focus groups and others consulted.

3.3.1 Hormonal control

The hormonal control method is distinguishable from the other biocontrol options being researched in that it would not involve genetic engineering. A toxin that would affect only certain cells in the pituitary gland, which produces reproductive hormones would be fed to possums. This would interfere with hormonal processes and make the possum permanently sterile.

Many people in the focus groups, and in other consultation, expressed a preference for this technique specifically because it was a non-GE option. There was also a widely held perception that this method would be more acceptable to the general public, and to overseas markets for New Zealand products, because it does not involve GE.

3.3.2 Interfering with lactation

There were strong negative responses to the biocontrol technique that would interfere with milk production in the female possum, thus reducing possum numbers through infant mortality. The humaneness of this technique was challenged in several of the focus groups, by the Wairarapa farmers, tangata whenua, and by representatives of environment groups and animal rights groups. There was general revulsion in response to the concept of cutting off the food supply to a helpless baby animal. There was a strong sense, consistent through all the focus groups and amongst the majority of others consulted, that targeting newborn or baby possums is highly offensive and would be much less acceptable than other control methods that focus on adult possums. The Wairarapa farmers' group was concerned that urban consumers would not find this method acceptable. Several groups argued that interfering with lactation was neither logical nor efficient – allowing an animal to be born and then killing it, rather than preventing it being born in the first place via a contraception or sterilisation method – *it's unacceptable, like not speying your female dog* (Wairarapa farmers). Ethical concerns were also raised – *stopping milk supply to the joey is more wrong, because it's more cruel* (E).

On the other hand, a number of people argued pragmatically that the issue was eradicating possums, not how this would be done - *get real, you have to kill them somehow* (P). Some people in the focus groups suggested that if this method met acceptability criteria such as specificity and safety, public education might be able to override the ethical concerns and initial distaste for this methodology - *it might be more specific than some other methods, which might make it more acceptable to the public* (S). There was occasional recognition of the inconsistencies in the general reaction against this proposed method, with acknowledgement from some people that if an adult female was killed by 1080, other poison or trapping, any pouch young would die of starvation anyway.

3.3.3 Increasing susceptibility to disease

Similar issues were raised while discussing proposed biocontrol techniques that would prevent the transfer of disease immunity from the mother to the pouch young - w*hy should a baby die a painful death from some disease? Why should a baby possum suffer through something like that, just because it's a baby* (W).

3.3.4 Sterilisation

Possum sterilisation using biological or chemical means was considered an option worth exploring by a number of people - *stopping them producing babies would be better than killing babies. Something can live out its life and just not have babies* (W). However, despite a perception that sterilisation would be more publicly acceptable than methods targeting lactation, a number of people in the focus groups raised concerns about a method that would aim to sterilise the developing pouch young - *It requires an extra generation to control them, and they will probably reproduce faster than they can be controlled* (S). It is noted that other sterilisation methods being researched would have immediate effects on adult animals.

The absolute and permanent nature of this intervention was perceived as increasing the risks involved with any potential use. The possibility of inadvertently sterilising wild and domestic animals, or humans, was raised as a significant concern for any future research into or development of biocontrol techniques involving sterilisation.

3.3.5 Contraception

Contraception, as distinct from permanent sterilisation, was generally supported by most investigation participants as the most acceptable of the proposed biocontrol methods. Some people in the focus groups noted that contraception is a technique that humans had been using for decades, and therefore is a familiar concept with which the public would be more comfortable than the other proposed biocontrol methods.

3.3.6 Delivery mechanisms

The range of potential delivery systems being considered to take a biocontrol organism out into New Zealand's possum populations was also outlined in the information pamphlet.

There was a clear and consistent reaction across all groups and sectors against the genetic modification of native plants on

which possums might feed. This was seen as an unacceptable encroachment upon New Zealand's biodiversity, and a risk to conservation values. Many people raised intense concerns that other wildlife including native birds, insects and invertebrates could also feed upon and live in such trees or other plants, and so be affected by the biocontrol as well as the target possums. There was deep concern about potential flow-on effects that might reverberate through ecosystems, and negatively impact on ecosystem processes and the dynamic relationships between species.

There was also widespread objection from both Maori and non-Maori to the actual modification of native trees or plants themselves. For tangata whenua, modifying the genetic composition of indigenous flora in order to introduce a possum biocontrol would be a disrespectful and highly dangerous disruption of the whakapapa and mauri of those plants, and the mauri and mana of the forests, ecosystems and landscapes in which they grow. It is possible that such modification might be seen as a breach of the guarantees of the Treaty of Waitangi in regard to the interests of tangata whenua in natural taonga, interests that require active protection by the Crown under the principles of the Treaty. These interests are currently at the heart of a major claim to the Waitangi Tribunal, the indigenous flora and fauna claim, WAI 262. (See 2.7.3) All tangata whenua consulted for this investigation were adamant that introducing alien genetic material to native plant species is not an acceptable option, regardless of the desirability of getting rid of possums. The Mangamuka hui passed a resolution:

> RESOLUTION 3: Mangamuka Marae, 18 April 2000:
> That we are totally opposed to the genetic modification of all native flora and fauna.
> CARRIED UNANIMOUSLY

These kinds of concerns were not raised in regard to the possible modification of exotic plant species.

The possible use of parasites, such as a gutworm that would carry a biocontrol through the possum population, received fairly cautious reactions in most of the focus groups and other consultation. The specificity of the parasite to possums was seen as critical. However, most of the people who commented on delivery methods were strongly concerned about the possible use and modification of viruses. Viruses were commonly perceived as too unreliable, unstable and likely to mutate in wild and extreme ways, thus potentially affecting other species – *you can't control it, it will mutate to keep itself alive* (P).

Other options outlined in the information pamphlet for delivery of a biocontrol were also considered, although these other delivery methods received less attention than the possible genetic modification of native plants. The idea of growing GM plants in strict containment and processing them to make a bait containing the biocontrol component, which would be spread in the same way as 1080 baits, was seen as a less risky option. Nonetheless, it was also viewed as inefficient and lacking any obvious advantage over current possum control tools. There was little comment on the concept of using an aerosol spray, triggered by the naturally curious possum pushing its head into a device that would painlessly squirt a biocontrol in a mist into its face (such mechanisms are currently being developed to deliver Tb vaccine to possums).

3.4 Genetic Engineering

In many of the focus groups, and at the hui and other discussion meetings, participants and interviewees made little distinction between biocontrol issues and genetic engineering issues. Given that all the biocontrol methods currently being researched, except one (hormonal intervention), would use genetic engineering, this rolling together of the issues was not surprising. There were expressions of general unease and concern about GE as such – *if we could do biocontrol without genetic engineering, I'd be a lot happier* (P). But one of the interesting patterns to emerge from the investigation was the generic basis of many people's responses to the proposed technology and its possible future uses. The series of questions put to the focus groups did seek separate responses to different aspects or levels of the issue – biocontrols *per se*, biocontrols targeting fertility, genetically engineered controls, delivery mechanisms – but for most of the participants, the issues were the same in regard to each level, and the approach was more thematic. The Independent Biotechnology Advisory

Council, in its report on *Public Views on the Biotechnology Question*, notes a similar "confusion" amongst the respondents making written submissions on its discussion booklet: "The terms 'biotechnology', 'genetic engineering', 'genetic modification' and genetically modified organisms' appeared to be used interchangeably".[3:1]

In addition, many of the concerns raised in the focus groups and in the PCE's other consultation were based in or influenced by people's feelings about genetically modified food, currently the most high-profile example of GE in the media and the public consciousness. Only a very few people amongst the non-specialist participants in the focus groups and in the PCE's other consultation were aware of other less controversial uses of GE, such as the production of insulin for diabetics. However, the typical blurring and mixing of responses is a clear indication that potential uses of this technology for such purposes as possum control will be inextricably interconnected with other questions, other information and other concerns from the wider GE debate. This issue is much bigger and more complex than the sum of its parts.

The PCE's analysis of the information gathered in this investigation therefore followed a thematic analysis approach, ranging across the spectrum of responses including biocontrol issues, pest management issues, genetic engineering, and the application of new technologies generally.

3.5 Safety and Specificity

The most common, immediate and powerfully expressed concern raised about possum biocontrols was that humans, other species, and the wider environment might be negatively and irreversibly affected. This fundamental concern is a powerful driver of people's responses to the proposed biocontrols.

In the focus groups, hui and other discussions for this investigation, safety was predominantly equated with specificity to the target species, possums. For many people this was a precondition for acceptability of the development and release of any biocontrol, whether or not it involved GE. These kinds of concerns were often based in a fear of the potential mutability of GMOs and biocontrol organisms such as viruses – *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). Safety concerns also extended to the potential for the organism to persist in the environment after doing its work on the target pest – for example, to pass on into other animals or invertebrates that might come into contact with dead possums or possum faeces – and thus to affect other species negatively.

Many people mentioned the particular risks that possum-specific biocontrols in New Zealand might pose for possums in their native Australia (the importation to New Zealand of RCD was cited by some people as an example of the ease with which such organisms can be spread from one country to another). It was insisted that New Zealand scientists researching possible biocontrols must keep Australian marsupial management authorities informed. It was expected that New Zealand would do everything possible in its research and development of these technologies to ensure that there would be no unintended adverse effects on possums and other species in Australia. (See 2.2.4).

Specificity also emerged as a significant component in the wider contexts of people's evolving understanding of GE, and their responses to its possible future applications. For many of the non-technical people consulted for this investigation, their previous concepts of GE seem to have been of a rather vague, generalised phenomenon, primarily associated with obscure technical procedures in the industrialised production of commodity foods (soybeans, canola, etc). Genetic science may have a high public profile, but amongst the non-specialist public many people have only a very broad-brush sense of what it actually does, how it works, and what effects it might have.

The PCE's investigation asked people to think instead about some very specific scientific techniques. Rather than a nebulous abstraction, people were faced with a purposeful applied science setting out to be capable of precise physiological interventions – designed to make its targets sterile, to prevent foetuses from developing in the womb, or to disrupt the supply of nutrients from the mother animal to the newborn. Previous research indicates that the specificity of the intended impacts of new technologies is a factor in acceptability of those technologies.[3:2]

3.6 Unpredictability and Unknowns

Closely linked with people's concerns about specificity of the biocontrol organism to the target pest were questions of the extent of predictability, or unpredictability, of biocontrol technologies and GMOs – *what if something goes wrong? What if it mutates?* (W). The general sense of the extraordinary powers of biocontrol organisms and genetic science perhaps only increases the fear that unexpected and unforeseeable consequences will arise from their use.

Many people were intensely concerned about the extent of what is as yet unknown with biocontrols, genetic science and their particular applications. Many were sceptical about whether even researchers and scientists working in these areas have sufficient understanding of the technologies and their potential impacts – *it's scary, nobody knows exactly what could happen. There is a lack of information, even the scientists don't know how it will affect things in the long run* (I).

Figure 2: The Unknowns

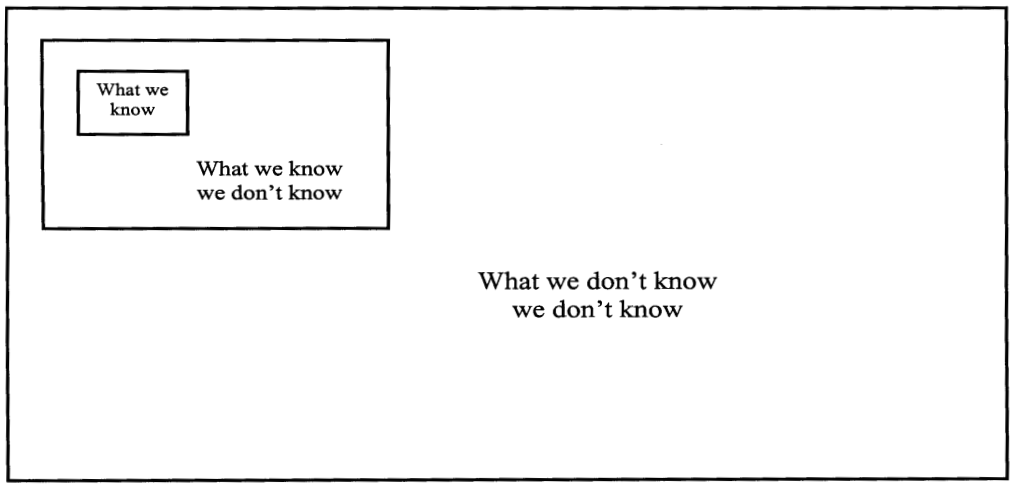

Figure 2 shown above indicates the relationship between the known and the unknowns in any process of scientific or other research. While there may be confidence in what is known, and to some extent in our understanding of the priority areas yet to be studied (those areas where we already know we don't have enough information), the serious concerns arise with those issues, dimensions or impacts of the new technology where researchers cannot even conceptualise the kinds of developments or effects that may arise, much less offer any reliable assessment or predictions. In some cases it may not be possible to identify critical issues, concerns or priorities until a research project or initiative is already some way down the track, and previously unperceived dimensions or developments emerge.

In many cases such unpredictability may have beneficial outcomes – the serendipity that, under a research regime allowing creativity and the freedom to follow opportunities, gives the kinds of break-throughs that can lead to exciting, radically new knowledge and products. However, in situations such as the current investigation, the extent of the unknowns surrounding the proposed technologies is widely perceived as a major risk factor and a significant obstacle to acceptance of the use of those technologies in the New Zealand environment.

Uncertainty stemming from these kinds of concerns led many to urge scientists and decision-makers to adopt the precautionary principle – *proceed with caution. When in doubt do nothing* (C). In any situation of such multi-layered levels of uncertainty and risk (perceived and potentially real), the precautionary principle is a critical tool for establishing credibility and confidence in official and scientific processes, and ensuring the protection of species and ecosystems from unnecessary disturbance. (See Box 5: Precautionary Principle 2.5.1)

Box 5: Precautionary Principle

The precautionary principle was defined in the 1992 Rio Declaration on Environment and Development (Principle 15):

> Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

It is increasingly commonly used in environmental management systems, and in environmental legislation, such as:

- the Fisheries Act 1996 (section 10(c)) which requires decision-makers to be cautious when information is uncertain, unreliable or inadequate; and
- the HSNO Act requirement (section 7) that ERMA shall take into account the need for caution in managing adverse effects where there is scientific and technical uncertainty about those effects.

The precautionary principle is widely perceived as a safeguard against the various unknowns, unforeseeable effects, unanticipated developments, and simple mistakes that might be entailed in a particular environmental management process, course of action, or introduction of new variables (such as a biocontrol) into ecosystems:

> The Precautionary Principle… is used when information suggests cause and effect but cannot prove it. Justification is on grounds of either complexity (an inability to unambiguously identify all cause-effect relationships) or inadequate previous knowledge on which to base the prediction of impacts.[P:1]

Although there has been extensive consideration of the precautionary principle in academic and environmental management papers, as yet it "has neither a commonly agreed definition nor a set of criteria to guide its implementation".[P:2] However, there is general agreement that the precautionary principle is fundamentally:

> The intuitively simple idea that decision-makers should act in advance of scientific certainty to protect the environment (and with it the well-being interests of future generations) from incurring harm… it requires that risk avoidance becomes an established decision norm where there is reasonable uncertainty regarding possible environmental damage or social deprivation arising out of a proposed course of action.[P:3]

Concepts associated with the precautionary principle include:

- sustainability constraints, or environmental limits to conventional paradigms of economically-driven expansion;
- willingness to be pro-active for environmental protection in advance of comprehensive scientific or other kinds of proof of possible consequences;
- understanding of the resilience or vulnerability of natural systems and resources to perturbation and change;
- understanding of the adaptive capabilities of systems and species, and of possible thresholds of irreversibility;
- placing the burden of proof on the proposer or developer of a method or technology (see 3.14 below); and
- recognising the longer-term timeframes within which environmental effects might become evident.

P:1 J Gough 1998: Environmental risk and risk management. New Zealand Science Review 55, 1-2, p 32.

P:2 T O'Riordan and A Jordan 1995: The Precautionary Principle in contemporary environmental politics. Environmental Values 4, p 194.

P:3 ibid.

Due to a widespread consciousness that many areas of uncertainty and unpredictability still exist with the proposed biocontrol technologies, many people in the focus groups and other PCE discussions insisted upon thorough, scrupulous trialling and testing of any biocontrol before its implementation could be considered. There was a strong sense that testing processes must be multi-generational and continue over sufficiently extended periods of time to check for unanticipated longer-term or cumulative effects. People insisted on testing for adverse effects of the new technologies over at least three (or five, or more) generations. How this could be done with a technology that induces sterility was not discussed; it is possible that the concept of several generations was intended to apply to non-target species, or simply to indicate an extended timeframe for more reliable assurance that unforeseen "down-the-track" consequences would be picked up.

Another area where unpredictability was raised was in regard to the reversibility, retrieval or potential unintended effects of a biocontrol mechanism once the goal of eradicating possums had been met – *what happens when the possums are gone? Does something else explode? What happens to the parasite when the possum dies?* (M). There was deep concern about potential unpredicted ongoing impacts of a biocontrol organism, or a "cascade" of effects that could move down through the "food chain", spreading through the ecosystem and affecting other animals, birds, insects or other invertebrates.

3.7 Humaneness

Humaneness was an important area of concern in both the focus groups and the PCE's other consultation. Humaneness was discussed in relation to the different specific biocontrol options proposed, and was one of the criteria for determination of relative acceptability of the options. Humaneness was also raised in many groups as an issue with implications for the present range of possum management tools, i.e. shooting, trapping and poisoning, and concerns about the length of time it can take possums to die with some poisons – *the more humane a control is, the better it will be accepted* (E). For the Wairarapa farmers, there was a consciousness of humaneness as a significant factor in the perceptions of New Zealand's farm management and environmental management practices amongst consumers in our overseas markets.

While for many of the focus group participants, their requirements for specificity and safety were absolute, issues of humaneness were not always so clear cut. Some people indicated a willingness to accept trade-offs, a pragmatic acceptance that it may be necessary to compromise humaneness because of the urgent need to eradicate possums—*I don't think the animal welfare argument will be a priority. The extent to which it will be made a priority depends on how pressing the problem is. It will become a more pressing priority, the more welfare-friendly methods become available, and less of a priority the more pressing the possum problem is seen to be in a particular area. Any method will be acceptable if possums are seen to be in plague proportions* (E).

Humaneness was talked about in many of the focus groups and in other discussions for this investigation. In most cases the discussion in these areas was in response to two of the proposed biocontrol methodologies - preventing lactation, and preventing the transfer of disease immunity from the mother possum to pouch young. There was a general sense that these methods would be too inhumane and cruel to be acceptable under any circumstances.

3.8 Effectiveness

The long-term effectiveness of possum biocontrols was viewed to be an important criterion in determining the viability and thus the desirability of this technology. In several of the focus groups, and in other consultation, questions were raised about how well the proposed biocontrol methods would actually work.

Amongst the questions relating to effectiveness was the critical issue of whether the controls would have permanent or only temporary short-term effects. If it would be necessary to reinfect possums regularly (thus requiring ongoing funding commitment year after year) it was suggested that there would be little advantage over current control methods. It was also asked whether

biocontrols would affect the entire possum population or whether some animals might have a natural resistance or immunity. The possibility that over time possums might develop an immunity to the biocontrol was seen as an important consideration. There was wide perception amongst the urban and non-specialist participants and interviewees that New Zealand rabbits had developed immunity to RCD and that this biocontrol introduction had been less effective than had been hoped - *RCD didn't keep working. What's the guarantee [a biocontrol] for possums would* (W); i*f farmers had realised that, by introducing RCD, they would produce a strain of RCD-resistant rabbits, they might not have rushed in and brought it into the country* (C). Recent research has shown that RCD has been more effective in some regions than others.[3:3]

For many focus group participants and others interviewed for this investigation, effectiveness was a function of the interaction between the biocontrol and the nature of possum population biology - *you have to kill somehow faster than they can replace, or they will breed up again. If you're only knocking out certain possums, you're allowing the others to thrive, you don't want them to breed up again* (E). There was a keen sense, particularly amongst the Wairarapa farmers and the members of conservation groups, of how quickly and opportunistically possums could re-colonise an area after a control operation. Questions were also asked about how reliably a biocontrol would spread from possum to possum, and how rapidly and comprehensively it would move through a population.

To some extent, at these relatively early stages of the research into possum biocontrols, these kinds of questions are strictly academic – not enough is yet known about how biocontrols would affect possums and their population dynamics in the wild. However, the kinds of concerns raised in regard to effectiveness by participants in this investigation should be given priority to be addressed in future research, in order to give the public and decision-makers confidence that the proposed methods will actually do the job.

3.9 Matters Raised by Tangata Whenua

As outlined in the preceding chapter (see 2.7) tangata whenua, as kaitiaki with responsibilities to past and future generations for the protection and wise management of natural resources, places and taonga, and with rights in respect of those taonga guaranteed under the Treaty of Waitangi and confirmed in statute, have a particular range of concerns in regard to proposed technologies such as biocontrols and genetic modification.

In the discussions undertaken with Maori for this investigation, the korero ranged widely, reflecting the complexity of these issues for tangata whenua and the serious concerns about the potential effects of the technology. Many of the concerns raised and debated by tangata whenua are the same kinds of things also brought up by scientists, conservationists, farmers and the wider public. Maori are intensely concerned at the ongoing damage done by possums to forests, ecosystems, and taonga species. There is also grave concern at the need to use poisons such as 1080 in the environment, which in some places (such as Mangamuka) has resulted in fierce opposition to the possum control projects of official agencies. Tangata whenua also raised questions about the effectiveness and practical potentials of the current methods for possum control; there was a strong emphasis at the Mangamuka hui on the opportunities that ground trapping methods offered for encouraging employment and locally-managed initiatives, and utilising the possum as a resource for fur and meat. There was a strong insistence on the expertise and skills of local communities, and their unique knowledge of local forests, landscapes and conditions. There was also a pragmatic assessment of the realities of hands-on possum control work from Te Rarawa, reminding the hui of the sheer physical demands of such operations in heavy, steep bush country.

In regard to genetic technologies and their possible acceptability for use in the New Zealand environment, tangata whenua raised major concerns about the uncertainties of genetic science and the potential risk to other species. They insisted on safety, specificity, and thorough testing of any new technology. There was also general concern about the perceived kaupapa and commercial focus of

much scientific research. There were strong objections to the proposed biocontrol methods that would interfere with lactation or the development of pouch young, as being too inhumane. There was recognition of possums as living beings with their own possum mauri, a part of the overall fabric of natural creation, and thus with the right not to be badly treated.

At the Mangamuka hui there was acknowledgement of the benefits that Maori had gained in the past from new science and technologies, in particular for medical advances, and the production of insulin for diabetics. Many hui participants agreed that research into new potentially beneficial technologies is important and should continue; there was a feeling that options should not be foreclosed. There was a clear and important distinction between research being conducted under strict controls in containment, and the release of new organisms or technologies into the environment.

Tikanga – the imperative of doing things within the frameworks of metaphysical, ancestral and traditional values and procedures – was the basis for many of the concerns about GE raised to the PCE's investigation team – *genetic engineering is alien to kawa Maori; they're trying to alter creation itself* (Mangamuka hui).

Whakapapa, and the relations between people and natural taonga, were raised as critical priorities – *changing whakapapa lines, it's too dangerous* (Mangamuka hui). There were strong concerns about such possibilities as an animal or other organism being genetically modified using human genes. In regard to the proposed biocontrol methods, the need to protect whakapapa, its tapu and its integrity, was fundamental to the unanimous rejection of genetic modification of native plant species as a way of delivering a biocontrol to possums. This was seen as an unacceptable interference with the whakapapa of those taonga plants.

There was intense concern about possible effects such modifications of native plants might have on other species in the forest or other ecosystems, especially birds. The potential impacts of such genetic changes on rongoa plants and their effectiveness were a matter of major concern. Increasing numbers of people are relying on traditional natural medicines to deal with a wide range of illnesses and conditions. The vulnerability of rongoa – not only the physical plants but their mauri, their metaphysical energies and essential qualities – to disruption by genetic engineering is a very significant concern.

The WAI 262 claim (see 2.7.3) was raised in relation to such concepts. Another important question was whether iwi would retain their traditional rights to taonga species, if these species were genetically modified. In some cases – for example with titi on the southern islands – the customary rights of tangata whenua to harvest are recognised and protected in legislation; other statutory provisions may apply in regard to the special interests of iwi in certain taonga species under settlements for Waitangi Tribunal claims, as in the Ngai Tahu settlement claim. Other formal relationships have been negotiated with official agencies such as DOC for tangata whenua access to whale bone, feathers and other customary resources. It was questioned whether such rights would apply in regard to genetically modified species.

The processes for decision-making in regard to the possible use of biocontrols and genetically modified organisms were also a matter of major concern. There was the view amongst some iwi representatives consulted for this investigation that the current processes of ERMA and other official systems do not adequately recognise and provide for the values and priorities of tangata whenua, nor for the fulfilment of their responsibilities as kaitiaki of natural taonga, places and resources – *what makes you think that kawanatanga is going to listen to us?* (Mangamuka hui). Particular concerns were expressed about the processes of consultation in regard to the application to ERMA for experimental cattle modified with human genetic codings. However, iwi representatives were consulted and involved in an AgResearch study into the rate of spread of a possum gutworm, *Parastrongyloides trichosuri*, which is being assessed as a delivery mechanism for a future biocontrol.

For many iwi and hapū representatives, consultation is in itself no longer adequate as a way of fulfilling the Treaty partnership; consultation is perceived as a reaction to someone else's initiative, rather than as being equally and fully involved from the outset in considering the options and determining the kaupapa.[3:4] At Mangamuka the view was also expressed that such technological management approaches were simply another

form of colonialism by the dominant Pakeha culture.

The issue of liability for any adverse consequences of the introduction of GMOs into the environment was another strong concern at the Mangamuka hui (see 3.15).

There was for some hui participants an almost fatalistic sense that GE would be inevitable, regardless of tangata whenua concerns – *if it all falls down, at least I stood up and opposed it* (Mangamuka hui).

Box 6: Mangamuka Hui Resolutions

Four resolutions were proposed and three carried at the hui attended by the PCE at Mangamuka on 18 May 2000:

1	RESOLUTION: **That as an alternative to biocontrols and genetic engineering, in order to address both the need to eradicate possums and to create sustainable employment in the form of a processing industry, this hui supports establishing a programme which pays bounties of possums to at least the current cost of eradication ($6 per possum).** CARRIED (3 abstentions)
2	RESOLUTION: **That legislation permitting the use of biological control of possums contains checks, balances, guarantees of liabilities for negligence to be imposed.** CARRIED UNANIMOUSLY
3	RESOLUTION: **That we are totally opposed to the genetic modification of all native flora and fauna.** CARRIED UNANIMOUSLY
4	RESOLUTION: **That this hui totally and categorically oppose genetic engineering in any shape or form for possum eradication.** UNDECIDED (6 abstentions, 3 iwi undertaking further discussion)

3.10 Ethics

> At the moment, as is so often the case with technology, we seem to spend most of our time establishing what is technically possible, and then a little time trying to establish whether or not it is likely to be safe, without ever stopping to ask whether it is something we should be doing in the first place.[3:5]

For many of the participants in the focus groups and many others consulted for this investigation, fundamental issues of ethics were at the basis of their responses. This came through in concerns about the extent to which humans should interfere with what is seen as the natural order of reality. For tangata whenua, tikanga is the basis for appropriate human relationships with the natural world (see above). But many non-Maori also approached the biocontrol proposals from a strong sense of what is right and wrong, and of the moral limits of acceptable human actions:

> Ethics is about… the ways we make meaning of our social world, and the values that are entwined in social practices. In ethical reflection we examine social relationships and the values expressed in them and subject those values to critical analysis.[3:6]

Some focus group participants expressed the view that genetic modification is not "natural" – *we're pissing around with nature too much* (P); *crossing species boundaries does not happen in nature* (P). Discussions of what is considered "natural" developed in one focus group into a debate whether genetic modification or "enhancement" of species is an evolution of centuries-old selective breeding techniques, or something on a completely different level. Most people in the focus groups and in the PCE's other consultation drew a clear distinction between "natural" breeding or grafting processes, where similar or related species are utilised for certain characteristics, and the introduction of DNA from totally unrelated

species – a commonly cited and generally objectionable example was the introduction into potatoes of genes copied from toads:

> We are, for better or worse, creating a new world… Growing GM food or transgenic animals, using gene therapy or prenatal genetic testing in human medicine, is not just about biological alterations. It is also about embedding in our societies an approach to food and medicines that understands our responsibilities to the biological world in new ways. It is bringing together capital, human work, and biology in new relationships [with] implications for how our society is organised, and how we configure social, economic, and political power, as expressed through such things as land use, different manipulations of nature, and understanding our bodies.[3:7]

Discussions around the ethical dimensions of the new technology also tended to focus around questions of how much is known, unknown, and perhaps ultimately unknowable (See Figure 2: The Unknowns). There was for some participants a profound concern that GE was a dangerous transgression of the limits of human capabilities – *messing with things we do not understand, maybe even things we do not know exist* (O). These concerns sometimes came through as a reflection of spiritual dimensions, but were more often related to a general sense of risk (see 3.11.3) and the need for extreme caution in advancing such radically new technologies as genetic engineering.

Questions of what can be judged as "natural" also centred around possums themselves. As introduced species, possums were not considered by some focus group members to be a "natural" or valid component of the New Zealand environment; thus a different set of ethical and management criteria might be applied – *if the risk is to indigenous flora and fauna there will be a lot of opposition to it. If the risk is only to another introduced species, I don't think there will be the same concern* (E). However the representatives of animal rights groups interviewed for the investigation, as well as many others in the focus groups, hui and other meetings, were very clear that any animal, whether indigenous or exotic, has the right to be treated humanely, and that if its removal or eradication is required this must be done appropriately and without cruelty or unnecessary suffering.

3.11 Risk

3.11.1 Assessing risk

In the focus group process and in the PCE's other consultation, inevitably the discussions of issues like predictability, specificity and effectiveness led people to the importance of assessing the risks involved in the development and application of biocontrol technologies in the New Zealand environment. There was a clear correlation between risk and the relative acceptability of the various proposed methods – *the issue for me is the specificity of the method, because it will alleviate a lot of the risk* (E) (See 3.19).

Risk assessment has made interesting developments as a discipline in recent decades. Using techniques based on the mathematical principles of probability, and on predicting the consequences of different potential scenarios, the science of risk assessment is a useful tool in the process of considering proposals for new technology and the implications for society.

Risk has been described as the probability that a particular effect (adverse or otherwise) will occur during a stated period of time. The Australia/New Zealand Standard on Risk Management defines it as: "the chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood".[3:8]

Risk assessment generally refers to techniques and methodologies to quantify risk. But our sense of risk, and our attempts to measure and manage it, are more subjective and less measurable. Risk perception will always be a matter of continual flux and evolution, under constant influence from many directions. This volatility is especially marked in relation to risk with proposals where there are high levels of uncertainty, extended timeframes (over years or decades), the potential for effects to be irreversible, and significant areas that are unknown or unknowable.

Amongst the factors contributing to perceptions of risk are [3:9]:

- time horizons – whether the risk is over the short or long term, whether the effects of exposure to the risk may be delayed in time;
- probability of the risk occurring;
- familiarity or newness of the risk;

- risk distribution – the principle that the risks should rest primarily with those who receive most benefit from the new technology or development;
- involuntary exposure to risk, where individuals, groups and communities have no alternatives or choice in their exposure to a particular risk;
- risk that is perceived to be harmful to future generations;
- lack of personal or societal control over outcomes, whether due to problems with the technology itself, or to inadequacies in consultation, public information, and decision-making processes;
- perceptions of the scale of unintended and potentially catastrophic adverse effects,
- the extent of scientists' and the public's knowledge about potential consequences;
- fear of the unknown, the primal dread factor;
- fear of change; and
- outrage.

One of the basic principles in risk management is to work to reduce the probability of failure or of unintended consequences to an acceptable level. How acceptable levels of risk are defined and determined, and by whom, are critical issues. Management of risk can involve:

- identification of relevant hazards and potential hazards;
- systems for monitoring and indicators;
- evaluation of:
  - magnitude and severity of adverse effects,
  - likelihood of occurrence,
  - contributing events and conditions,
  - the significance of what may be adversely affected,
  - public views and values,
  - conflict or controversy associated with the issue, and
  - areas of uncertainty and ignorance.

3.11.2 Risk and biocontrols

Research into conventional biocontrols and their environmental impacts suggests a number of important factors, including the necessity for careful and comprehensive testing, which may apply to future biocontrols for possums utilising genetic engineering:

> The environmental safety of biological control, earlier taken for granted, is now a topic for debate… lack of evidence for adverse environmental impacts of biological controlintroductions can be attributed more to lack of study of effects than the absence of such impacts… pre-release testing, when carried out, has rarely included non-target indigenous species…
>
> Limited taxonomic and ecological knowledge is a critical problem in studies of non-target host range, and particularly in New Zealand where the fauna is so poorly known and incompletely described. This precludes an exhaustive study of potential hosts and objective selection of species for laboratory testing, and hence to some extent compromises prediction of impacts…
>
> Environmental impacts of biological control agents can be… extremely complex and [research has] emphasised the need to monitor effects on other species in the food web, spanning three or more trophic levels. An indirect effect of an introduced organism could be increased competition for a host/prey with native natural enemies, or habitat modification… While there are few documented cases, there is circumstantial evidence to suggest that biological control agents have the capacity to cause species extinctions, particularly in island communities.[3:10]

Recent studies have drawn attention to the unpredicted and devastating effects on world wildlife populations of newly introduced organisms or other impacts on their habitat environments:

> Griffon vultures are merely the latest in a long line of wild animals that have fallen prey to 'emerging diseases', caused by pathogens that may have been harmless in their original setting, but turned nasty when released among previously unexposed hosts… All over the planet, lethal infections are killing off populations of creatures ranging from abalone to kangaroos, from coral to honeybees, and from pilchards to flamingos.[3:11]

3.11.3 The impossible dream: zero risk

When considering questions of risk and the requirements of risk assessment, a number of the focus group participants and others consulted for this investigation,

acknowledged that their desire for zero risk – absolute safety or absolute confidence in a new technology – was an impossible, unattainable ideal. Many people were well aware that 100% safety assurance would never be possible, even with the most rigorous science. Yet many appeared unable to let go of the ideal – *what worries me is we keep hearing 'there is no proof that this is harmful'. I don't want to hear that. I want to hear 'we have done the research and we can now prove that it is not harmful'. When we get to that stage, I'll clap my hands and say 'yeah, I agree with genetic engineering'* (C).

This tension was often evident in a preoccupation with the processes of establishing certainty, the business of testing and trialling any new science and its applications – *scientists have to research it to the point where they have looked at every possible scenario where it might go wrong, and we feel comfortable that it won't* (M). There was a widespread consciousness of the importance of adequate testing, although for many there was little detailed understanding of what might be entailed in "adequate testing" of a radically different new technology that might be self-perpetuating in the natural environment. Some discussions of risk management and appropriate testing expressed no more than a generalised insistence on thoroughness and scrupulousness – broad principles that were upheld as prerequisites for public confidence in the process. Perhaps such generic-level concepts are inevitable when people have not yet had great experience with more practical, targeted risk assessment and testing procedures; perhaps they are a reflection of the depth of people's instinctive concerns in the face of such fundamental levels of scientific imprecision and uncertainty in relation to new technologies that could have potentially far-reaching effects and outcomes.

Some people, groups and others consulted by the PCE focused beyond questions of biocontrols, on the risks perceived to be inherent in GE technologies generally, due to the transfer of genetic material between unrelated species, and the development of organisms that would never have evolved naturally. Opposition to GE is founded (amongst other concerns) in an acute consciousness of risk – the understanding that knowledge is lacking about the direct and associated risks of this technology, that the outcomes are unpredictable, the effects may be devastating and irreversible, and there has as yet been no long-term testing nor independent third-party safety testing. At the core of the opposition to GE is the urgent concern that the consequences may be potentially catastrophic, yet the development and (more so overseas than in New Zealand) application of the technology continues with unnerving speed, fostered by economic interests and competition in technology markets. The commercial dimensions of much of the development of GE only intensify concerned citizens' sense of risk and of the apparent uncontrollability of the GE "tidal wave":

> [W]ith biotechnology (as with nuclear technology and the use of pesticides and herbicides) the risks are not carried by the individual who makes the decisions, nor only by those who stand to gain from the use of technology. Risk is carried by the society, by those who may not benefit at all, and/or by future generations.[3:12]

3.11.4 Risk and timeframes

The timeframes of research and development, and the time horizons involved before the proposed biocontrol methods reach the stage of implementation, were highly significant factors in the discussions around risk and acceptability in both the focus group process and the PCE's wider consultation. Almost every meeting and discussion raised questions about how soon the researchers would have the biocontrol technology to the stage where it could be considered for use. For some people there was a degree of scepticism about the researchers' explanations that this would be perhaps as far away as ten years. There was a widespread consciousness that GE is a science that is developing at a very rapid pace – *the science is on an exponential curve – in two years' time we could have totally new techniques* (scientist at Wairarapa farmers' meeting).

There was also a sense amongst a few participants that public perceptions of such technologies and of risk also change and evolve over time, perhaps rapidly. For the Wairarapa farmers' group, this was evident in the shifting attitudes of the public, both in New Zealand and in our overseas markets, to various technologies used in agricultural production – *perceptions change all the time, in 10 or 15 years' time, [opposition to GE]*

could change (Wairarapa farmers). Resistance and distrust increase when application of what is perceived to be a complicated high risk science is considered to be imminent, with little time available for consideration and learning about the issues at stake. Distrust is intensified with the sense that the public have been "kept in the dark" during years of research and development of a technology perceived to be potentially dangerous. In several meetings participants expressed their appreciation of the PCE's investigation raising the issues about possum biocontrols well in advance of the point when such technologies would be being proposed for release.

3.11.5 Risk and language

Also significant for risk assessment are the kinds of language and conceptual frameworks within which risk is defined and discussed. Different groups and sectors deal with challenges such as new technologies in ways that reflect their respective worldviews – cultural, community, traditional, professional or academic. The terms, narratives and vocabulary used in processes such as risk assessment will have different meanings and power depending on the framing assumptions that apply:

> The public assesses risk subjectively, qualitatively and often emotively. Engineers distinguish between their view of risk and that of the public by use of the terms 'real risk' and 'perceived risk', with the clear inference that the perceived risk is a misconception. Psychologists and sociologists often have a very different view. They see risk as a state of mind, and distinguish between the public's view of risk and that of the engineers as 'real risk' and 'calculated risk'.[3:13]

Among the most obvious of these kinds of disjunctions are the differences between the language and expectations of scientific researchers compared to the lay public. Other kinds of frameworks for approaching issues of risk include economic, political, ethical, religious or metaphysical, ecological, and the tikanga tuku iho of tangata whenua.

3.11.6 Risk assessment frameworks for biocontrols

Some of the common themes and concerns emerging in the focus groups and other discussions for this project, as well as some of the priorities coming through in recent developments in relation to GE food, suggest some critical questions for risk assessment of possum biocontrol technologies:

- How much is enough testing? How safe is safe enough? For how long do experiments and trials need to run? How large a sample of potentially-at-risk species and non-target species needs to be surveyed?
- How do we know whether our trials are checking for the right signs or responses? Of all the possible ramifications or effects, long term and latent, synergistic and cumulative, how can we be sure we are testing for the kinds of things that will be important? What different kinds of trials will be needed to test efficacy in regard to the target species and possible effects on non-target species?
- What if even the experiments and trials to assess impacts turn out to have some unforeseen and irreversible adverse effects?
- How will the risks to taonga, and to the intangible and metaphysical dimensions for tangata whenua, be assessed? What kinds of trials might be relevant – or might a determination be made on the basis of tikanga that testing would itself be unacceptable? When the introduction of rabbit calicivirus disease was being considered, Ngatihine offered sacrificial kiwi for the necessary scientific tests, but what would be the testing requirements for assessing the potentially wide-ranging environmental, cultural and metaphysical impacts of such techniques as genetically modifying native plant species to deliver a possum biocontrol? What kinds of risks might there be to those species and their value as taonga, and to the places, landscapes and sites where such organisms might be tested or released? What kinds of processes, under the Treaty of Waitangi principle of active protection of the rights and interests of tangata whenua in their taonga, will be necessary for iwi and hapū to determine and communicate those risks?
- What about assessing the risks to the intangible cultural, spiritual, ethical and traditional values of non-Maori New Zealanders?
- How does one set about proving a negative? It is theoretically an impossibility to establish that a technology or new organism will have no undesired effects, because the number of potential effects is statistically infinite; the process

of testing different things for different outcomes in different conditions and circumstances could in theory continue, always inconclusively, into perpetuity.

3.12 Benefits, Risks and Costs

Another interesting dimension to the responses about risk in regard to biocontrols was the consideration and weighing of the various benefits, intended benefits, risks and costs associated with the different methods. For some focus group participants, the willingness to trade off risks was related to what the technology is intended to achieve, and its effectiveness at dealing with urgent environmental problems – *is the risk worth what we are trying to do?* (S). Many people in the focus groups and other PCE consultation seemed to be grappling with a sense that the benefits of biocontrols might justify an acceptance of greater risk.

There was a sense amongst many people in the focus groups and other PCE discussions that biocontrol technologies, even those involving GE, are different from other kinds of potentially risky scientific developments because they are designed purposefully to deal with a major environmental problem – possums and the damage they do to the New Zealand environment (see 2.2.1). There was broad appreciation of the distinction between these kinds of applications of genetic science and the commercially-oriented development of GM foods (see Box 7: Acceptability and Benefits).

However, there were also high levels of uncertainty and concern about the kinds of motivation and direction perceived or suspected to be behind the new technologies in general – who wants this bioscience? Who is promoting genetically engineered methods? Who will receive a return or an advantage from these technologies being developed and used? What exactly will be the nature of those intended benefits?

At present there is little specificity about what results the proposed biocontrols might actually deliver. There are vague perceptions of great potential, but the technology is still only in its early stages, and there is much more work to be done. Many people in the focus groups, hui and other PCE consultation felt strongly that for robust decisions to be made about these new proposals, they would require more solid information and reliably substantive evidence of the benefits and advantages of the technology.

Table 1 gives a preliminary summary of the kinds of benefits that might be derived from the development and use of biocontrol technologies for possums, and an indication of some of the costs and risks that might be involved for different sectors.

Box 7: Acceptability and Benefits

For most people, assessments of acceptability will be related to the perceived benefits of the particular application of the technology. However for some individuals and groups, some things will be unacceptable, as a matter of principle, under any circumstances.

There will be greater acceptability of a new technology where there is a clear understanding that worthwhile benefits will be gained – or conversely, where there are perceived to be no other viable options for dealing with a problem. In the case of proposed biocontrols for possums, it was a significant factor for many of the people consulted that the technology is intended to help control an unwanted pest that is causing enormous environmental damage.

In Figure 3 on the opposite page, acceptability is portrayed as different for healthy persons and for those suffering from conditions for which risky technologies (the use of which would be a personal decision) may provide assistance. In the current investigation similar patterns can be seen in the relationships between participants' sense of the limited effectiveness of current possum control methods, and their willingness or perceived need to consider new biocontrols and genetically engineered methods.

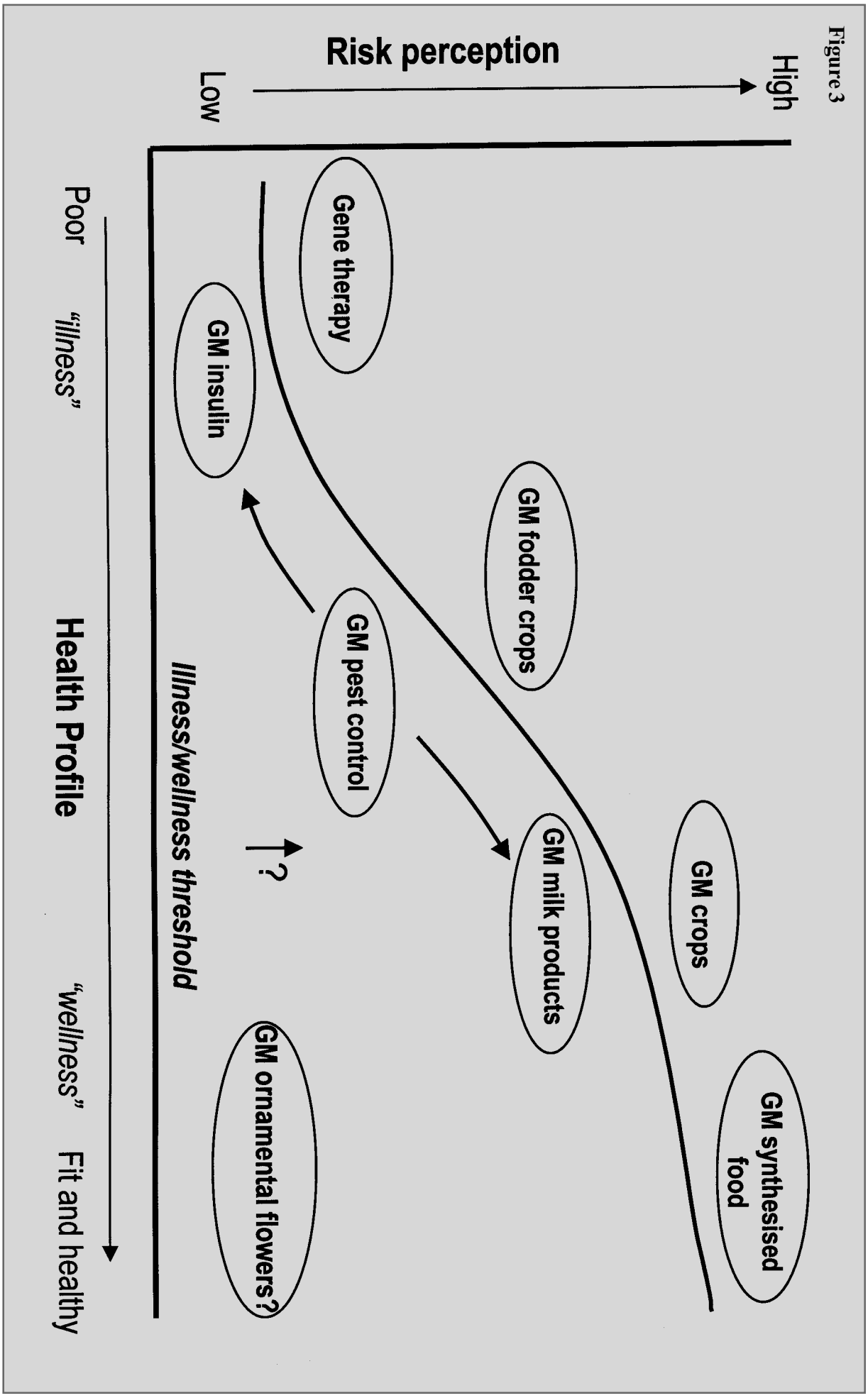
Figure 3
Risk perception
Low
High
Poor
"illness"
Health Profile
"wellness"
Fit and healthy
Gene therapy
GM insulin
GM fodder crops
GM pest control
GM crops
GM milk products
GM synthesised food
GM ornamental flowers?
?
Illness/wellness threshold

Pest management agencies	• Reducing ongoing burden of pest control costs • Minimising practical management demands • Reducing exposure to liability for non-target deaths from use of current toxins	• Research projects or contributions to research • Costs of application for approval • Implementation costs • Consultation & communication • Research into local priorities • Staff training • Monitoring • Opportunity costs of not exploring other options	• Liability for any effects arising from the implementation
Scientists	• Individual research careers, and career satisfaction • Personal commitment to NZ landscapes & biodiversity • Increased public confidence in science & technology	• Opportunity costs in other research areas not pursued	• Further erosion of public confidence in science if any adverse effects, or if processes & testing seen as inadequate
Crown Research Institutes	• Funding for current & ongoing possum projects • Maintaining critical staffing levels • Spin-offs and expertise from developing the capability • Future marketability of fertility-focused biocontrol technology to deal with other pests • Intellectual property in new knowledge and techniques • Increased public confidence in science & technology	• Information & communication to the public & interested parties • Research into public attitudes • Training, equipment, infrastructure • Monitoring obligations – ongoing commitment to check for any delayed effects • Opportunity costs of not exploring other options	• Liability for any effects arising from the research processes • Liability for testing & safety assurances • Further erosion of public confidence in science if any adverse effects, or if processes & testing seen as inadequate • Risk that NZ's research efforts might be eclipsed by much larger, more well-resourced overseas research agencies or corporations working on pest management

Table 1: Potential benefits, costs and risks of biocontrols for possums

Who might benefit?	*Potential benefits*	*Potential costs*	*Potential risks*

Public good	• NZ's landscapes & environment
	• Perceptions of NZ as "clean & green"
	• NZ economy via maintenance of exports of animal products, horticulture, forestry
		• Public research funding commitments
		• Public information programmes
		• Participation processes
			• Adverse effects on
			  • The environment
			  • Human health
			  • Other species
			• Effects on NZ's "clean & green" reputation of perceptions of GM biocontrols as "unnatural"

Conservation & biodiversity	• Recovery of forest & other ecosystems
	• Recovery of threatened species, plants & birds
	• Reducing ongoing burden of pest control costs
	• Minimising use of 1080 & other toxins
		• Opportunity costs of not doing other priority conservation work
		• Time lag with methods targeting fertility
			• Adverse effects on
			  • Ecosystems & processes
			  • Threatened species, plants & birds
			• Irreversible effects or extinctions

Tangata whenua	• Recovery of forest & other ecosystems
	• Recovery of taonga species
	• Reducing ongoing burden of pest control work
	• Minimising use of 1080 & other toxins
		• Contributions of time, expertise & local information
		• Participation in official processes
		• Korero processes within iwi, hapū & whanau to consider issues
		• Monitoring for effects on taonga
			• Adverse effects on
			  • Whakapapa, mauri, tapu
			  • Taonga species, te taiao, ecosystems & processes
			  • Wahi tapu, wahi taonga & heritage landscapes
			  • Rongoa
			  • Human health & well-being
			• Irreversible effects or extinctions
			• Failure of official systems to adequately recognise & provide for tangata whenua rights & concerns
			• Risks to rangatiratanga & fulfilment of kaitiaki responsibilities

Agriculture & forestry (production sector)	• Minimising possum damage to crops & resources • Reducing bovine Tb risks, & threats to NZ's exports • Reducing ongoing burden of pest control costs • Minimising practical management demands • Reducing risks from 1080 use	• Research projects or contributions to research • Costs of application for approval • Implementation costs • Training staff in new technologies & issues, or purchase of these skills • Opportunity costs of not exploring other options	• Losses of productive capacity due to unforeseen effects • Negative reactions of NZ's overseas markets to use of GMOs in our environment

3.13 Alternatives

An important factor in undertaking any assessment of risk is to give adequate consideration to available alternatives to the proposed course of action. A significant proportion of focus group participants and others consulted for this investigation returned again and again in discussions to debating the range of alternatives for possum control.

The new biotechnologies were seen by some participants in the focus groups as an alternative to New Zealand's current control methods for possums, particularly the widely unpopular poison 1080. Some evaluations of the particular biocontrol techniques outlined in the information pamphlet (Appendix C), or of GE generally, tended towards an either/or approach, where the two kinds of technology were weighed against each other.

However, in other discussions, notably amongst the Wairarapa farmers' group and in interviews with pest control managers, there was acknowledgement that biocontrols would not on their own be the ultimate solution to New Zealand's possum problems, and that it would still be necessary to use poisons and trapping, in conjunction with biocontrols.

Despite acknowledgement in most of the focus groups that New Zealand is making only limited progress with the current "tool-box" of possum control methods, many people expressed confidence in those methods (see 2.2.2 and 3.2.2). Only a very few people endorsed other alternatives for possum control, such as biodynamic methods.

It was suggested in some groups that if levels of funding equivalent to biocontrol research allocations was put into possum control using current methods, New Zealand might make significant impacts on its possum problem and thus might not need to consider perceived high-risk biocontrol options at all. This was often expressed in the context of discussions of the opportunities to utilise possums as a resource, providing both employment for teams of trappers, and income from fur. For many of the more pragmatic focus group members in the Levin and urban community groups, the solution was not in some potentially dangerous new science, but in good old Kiwi practicality, getting teams out into the bush to deal "hands-on" with possums. It was noted in the Wairarapa farmers' group that biocontrol technologies were still many years away and, in the mean time, New Zealand must do the best with conventional control methods.

For the environmental and conservation NGOs, and in the focus group comprising people with a particular conservation orientation, the question of alternatives to GE biocontrols was part of a broader consideration of pest management principles for the protection of New Zealand's biodiversity. Key questions for this sector included:

- Why do we need biocontrols?
- Why do we need genetically engineered responses to the possum problem?
- Have we exhausted the possibilities with our existing pest control methods?

A consciousness of alternatives also came through strongly in the focus group discussions in relation to the orientation of New Zealand's possum control research. Many participants were concerned at the focus on GE biocontrol methods which was perceived to be at the expense of research into other potentially less risky options. There was also concern at the annual amount being invested in GE research areas. It was felt that exploration of more environmentally benign alternatives was not being given adequate priority. Some people challenged science to explore other ways to limit possum numbers – other techniques, vaccines, or interventions in the possum life cycle – that need not involve GE. There was for some a sense, almost wistful, that recent years' emphasis on genetic technology may have already foreclosed on New Zealand's capacity to develop other areas of research into control technologies that do not have the potential risks of GE-derived methods.

3.14 The Burden of Proof

For many of the focus group participants and other interviewees, a fundamental question was the burden of proof for the safety, acceptability and benignity of the proposed bioscience and its application for possum control. The concept of the burden of proof is central to risk assessment processes and to audit and accountability systems. The basic principle is that responsibility in regard to the safety, effectiveness and reliability of a proposed technology or management system must lie with the operator or beneficiaries of

that technology or system. The burden of establishing sufficient certainty in regard to safety and benignity is the duty of the proposers, developers or aspiring users of the technology.

It has been argued that this responsibility extends to research and active monitoring to be able to demonstrate that the use of the technology does not cause damage, rather than simply assuming this to be the case until demonstrated otherwise. Under the basic requirements for sustainable environmental management established under the Resource Management Act 1991, the effects of development activities require thorough environmental impact studies and are carefully regulated. Continued monitoring is required, and information is accessible to the public.

Given the potential beneficial outcomes of bioscience for possum controls (see Table 1), it would seem that for this particular technology the burden of proof of effectiveness and safety is a shared responsibility across several sectors and interested groups. New Zealand's pest management and research agencies do have collaborative systems, such as the NSSC and NPCA, for advancing research and development. These structures would be a logical starting point for the development of integrative processes for evaluating the planned benefits of biocontrol technology, and the associated obligations of the various parties. Sorting out these kinds of issues will necessitate the involvement of economists, ethicists, tangata whenua, councils and communities as well as scientists (social, physical and ecological).

There are fundamental tensions in the differences between the public good and private or commercial interests (similar to the sectoral differences the PCE found in 1999's investigation into marine and fisheries management):

> Over the past decade we have seen constant restructuring of our science community… Alongside the increased managerialism comes the demand for profit, coupled with a battle for control of resulting intellectual property… there has also been a move away from investigator-initiated research and a move towards funding for specific outputs or outcomes determined largely by non-scientists.[3:14]

Questions of an appropriate balance for the CRIs' research and development programmes between commercial objectives and public good research emerged through the investigation and will be a critical issue. There was forthright scepticism in some of the focus groups and other PCE consultation about the work of the CRIs – *the scientists are still getting paid, even if the research goes wrong* (Mangamuka hui). Resolving such matters is imperative to advance understanding in this complex area, and to ensure wide societal acceptance of the decisions eventually reached about whether or not to release a possum biocontrol technology.

3.15 Liability

Liability for the possible adverse effects of a biocontrol or a genetically modified organism in the New Zealand environment was raised as a point of intense concern for a number of the groups and others consulted for this investigation:

> Mechanisms for ensuring that those who initiate decisions with potentially damaging outcomes (because thresholds are possibly near) should be responsible for any consequences… The onus of proof is shifting towards the risk creator.[3:15]

There was for many people consulted an acute sense of the potentially enormous costs that could be involved if a biocontrol or GMO was to have unanticipated negative effects – which might in a worst-case scenario include effects on livestock and domestic animals, crop plants and forestry, human health, or wildlife and native plants. It was strongly held that, should adverse effects occur, there must be accountability of those agencies, companies or science institutions responsible for the development and introduction of that biocontrol technology, and a clear course of redress for those affected. People in the focus groups and hui insisted that there must be clarity as to who would meet the costs involved if there were unintended effects or accidents; costs might consist of remedial action and restoration, mitigation of effects, or compensation. It was noted that adverse effects might become evident only over the longer term, and thus that frameworks for liability should be ongoing in perpetuity.

At the Mangamuka hui, after considerable discussion on these issues, the following resolution was passed:

> RESOLUTION 2: Mangamuka Marae, 18 April 2000:
> That legislation permitting the use of biological control of possums contains checks, balances, guarantees of liabilities for negligence to be imposed.
> CARRIED UNANIMOUSLY

In some discussions for this investigation, reference was made to the high profile claims brought against the tobacco industry in the US for the negative effects of their products, and the millions of dollars awarded in damages in those cases. However, in regard to liability for possible adverse effects of genetically modified organisms, the overseas experience is salutary. A recent decision by the European Parliament ruled that:

> … GM producers, such as Monsanto, should not be held legally responsible if their food turned out to be harmful for humans or the environment. In a vote which attracted fierce lobbying from biotechnology companies and environmental groups, [members of the European Parliament] rejected moves to make GM firms liable for their product by 287 votes to 202…
>
> Labour MEP David Bowe, who tabled the original liability proposal, said… 'they are clearly not prepared to put their money where their mouth is. If GM companies have no confidence in their products' safety, why should European consumers?'… GM firms, represented by a lobbying coalition called Europabio… had argued that if [they] were made legally liable for damage caused by their products they could be saddled with unreasonable costs and a huge amount of red tape.[3:16]

Elsewhere overseas, legal claims have been brought by farmers whose crops have been contaminated by GM materials.[3:17] In Canada, farmers are campaigning that the government should "make agro-biotech firms liable for damages caused by genetic pollution".[3:18] And in the US:

> The insurance industry has consistently refused to write policies covering liability for harm caused by genetically modified organisms… the US rejection of liability suggests that US agribusiness and the US government have less confidence than is proclaimed publicly in the safety of the products approved and in the integrity of the product review process.[3:19]

In New Zealand, in addition to the statutory provisions under the HSNO Act and other legislation, (see 2.9.4-2.9.7) the ordinary civil law applies to any possum control programme whatever the control mechanism used. If animals (other than the target possums) or other property are damaged or destroyed by a control mechanism, the owner of those animals or other property may be able to sue the possum control agency.

Whether any claim would be successful would depend on the exact facts of the case, but the principle has been established in legal cases involving adverse unintended effects of existing pest controls. There have been a number of cases over spray drift, particularly of herbicides, where the sprayer (or their employer) has been held liable under the law of negligence or the law of nuisance for damage caused by the spray.[3:20] Substantial damages can be awarded where, for instance, crops are destroyed. Another case involved aerial release of 1080-poisoned carrots that were accidentally dropped on the wrong area, killing deer on a deer farm. Although that case has not been resolved, the owners of the deer sued the Regional Council in both negligence and nuisance, and also claimed against the helicopter operator under the principle of strict liability as provided for in the Civil Aviation Act 1990.[3:21]

The insurance industry in New Zealand does not yet have an official position on issues involving genetically modified organisms in the environment. To make an insurance claim for any adverse effects arising from the use of a biocontrol organism causing loss or damage, negligence would first need to be established followed by verification of legal liability. Genetic engineering is not normally listed as an insurance exclusion in the current New Zealand insurance market. An industry spokesman suggested that in the future, when more is known, all liability cover for GMOs may become a specific exclusion, similar to nuclear risks. At present it would be unlikely that insurers would intentionally take on the GMO liability risk without fully understanding the issues. There is a general feeling amongst the industry that the risks involved with GMOs in the environment are just too great for insurance companies to accept.

In its report on the feedback received on its first discussion paper on biotechnology, IBAC noted that: "Some insurance companies have elected not to cover some risks associated with biotechnologies. This is an important issue for… the agricultural sector. Liability issues… need to be explored".[3:22]

3.16 Multiple Objectives

In some of the focus groups and through the PCE's other consultation, consideration of the issues surrounding possum control technologies ran up against some underlying differences in the goals, benefits, objectives or outcomes that are being sought by the various stakeholders. It soon became evident that there can often be a number of objectives, motivations and aspirations amongst the different groups and interested parties. These various goals may be similar, even overlapping, and share common ground; they may be incompatible, contradictory or even mutually exclusive. They may be shaped within different criteria and timeframes – for example, the shorter-term objectives of developing a possum fur industry to utilise such a prolific resource, as opposed to the long-term goal of eradicating possums.

A number of the diverse goals of different stakeholders in the possum control arena were identified in the discussion process for this investigation; they include:

- protecting native plants and animals, and New Zealand's natural landscapes and ecosystems;
- protecting the taonga of tangata whenua;
- fulfilling the Crown's obligations to tangata whenua under the Treaty of Waitangi;
- protecting New Zealand's cattle and deer herds from bovine Tb;
- getting rid of a destructive, invasive pest;
- maintaining New Zealand's "clean green" image overseas;
- ensuring the ongoing viability of New Zealand's exports;
- maximising New Zealand's advantages in agricultural production;
- ensuring New Zealand maintains a capacity in science and development research, and building a competitive advantage in the development of science-based services and products;
- fulfilling New Zealand's international commitments under the Convention on Biological Diversity and other agreements;
- utilising local communities' skills and commitment to work with pest management at the local level;
- utilising the possum as a resource of fur and meat from which income can be earned.

3.17 The Spectrum of Perception

Reflecting and helping to shape this diverse range of objectives of the various stakeholders in possum control, there are a range of different worldviews, paradigms or frameworks of perception, value and expectation, that became very apparent over the course of this investigation. As with the spectrum of goals or objectives, some of these worldviews share common goals or characteristics, some develop their own position on the basis of their difference from others, some even take strength and identity from their active opposition and adversarial stance relative to other players in the pest control and GE arenas.

Agreement or alignment between these different views may not always be possible or desirable. However, New Zealand will not be able to develop a broadly held, strategic understanding about the role of genetic science and its appropriate application for such purposes as pest control unless the full spectrum of distinctive perspectives is recognised, made explicit, and given as much opportunity as necessary to have their say. The hearings of the Royal Commission on Genetic Modification will help to clarify the range of views and positions on these issues.

There is also a rich spectrum of conflicting and contradictory information available, both reliable and unreliable, much of it gathered from the internet, which feeds and contests the respective arguments of different groups and parties in debates about matters such as pest control, environmental management and GE. With an exotic new technology such as GE, where people are acutely conscious that there are as yet great unknowns and uncertainties, it is important for people to establish what solid ground they can find in a base of information.

In the focus groups and other discussions undertaken for this investigation, the

spectrum of worldviews was evident in a number of ways – in regard to the kinds of criteria on which people made their assessments of acceptability, the weighting given to different kinds of information, the kinds of language and approaches to communication adopted, and the processes by which individuals were working towards some kind of personal position in relation to biocontrols and GE.

Box 8: Huckleberry Finn – What Is Truth?

It is not easy to change one's fundamental beliefs about life, and there can be agony in changing familiar patterns. Issues with moral, ethical and emotional dimensions are difficult to debate. Long-standing or strongly held beliefs may be assumed to be ultimate truth or established fact by those who hold them. This is illustrated by the struggle faced by Mark Twain's Huckleberry Finn.

Huck was brought up to believe that private property rights included the right to own slaves and that God ordained that slavery. Therefore helping a slave to evade re-capture or actively assisting escape was to his mind wrong and sinful before God.

In the story Huck knows the whereabouts of an escaped slave. He knows this man, Jim, to be a warm and gentle human being; he knows him as a friend. Huck is torn between doing "the right thing" – that is, telling the slave's owner where Jim is – and doing what his own consideration and compassion tells him is best. He resolves not only to conceal Jim's whereabouts but also to help him in his bid for freedom. After working it through and coming to his decision Huck says to himself "All right then, I'll go to hell."

Huck had the courage to challenge his own and society's fundamental standards and norms of behaviour. While he still believed that his actions were "wrong" he found that there was more than one way of evaluating the choices that he had to make. This ability to critically examine our own beliefs and values, and to consider the possibility that we might be wrong, is essential to open debate on any issue.

3.17.1 Scientific information and personal experience

The wide-ranging discussions in the focus groups and other consultation for this investigation brought together both objective, rational, scientific approaches and subjective personal areas of feeling, values and experience. Our discussions about biocontrols and GE often ran between this polarisation – on one side, information gathered from authoritatively disciplined research methodologies, whether biological, environmental and genetic sciences or the fields of economics and commerce – and on the other side of the debate, the immediacies of subjectivity, the beliefs, understanding, and personal contexts of each individual.

This fundamental disjunction is a significant constraint on the debate. The different parties, groups or sectors often seem to be talking past each other. Technical facts jostle against elusive feelings, quantification against emotion, the formal against the personal. Differences in the vocabulary and language used by various stakeholders, in their approaches to communication, and their underlying expectations about how the issues will be framed, often result in only partial or imperfect communication: "The problem with communication is the illusion that it has been accomplished" (George Bernard Shaw).

Some people working in science, agricultural production, and the official agencies expressed a rather touching faith in the power of scientific data to dispel public confusion, fear and distrust. The assumption amongst a number of the technical, official and industry spokespersons consulted for this investigation was that a lack of sufficient scientific information is at the heart of people's concerns or opposition to a particular technology or its application. There is also the expectation amongst these stakeholders that only science – perceived by many of its practitioners and advocates to be rigorous and accurate, distanced and disinterested, objective and value-free – can provide the solid, reliable data, and the kinds of frameworks and methodologies for

conducting a debate, that will lead to satisfactory conclusions.

The limitations of these kinds of paradigms of science have been explored by many commentators[3:23] and can be seen at work in the debates about biocontrols and GE:

> Increased public knowledge of a technology does not necessarily lead to it being perceived as beneficial… Support for these [technologies] by New Zealanders was found to be better predicted by moral acceptability than expectation of risk… public concern is unlikely to be alleviated by technologically-based reassurances…[3:24]

> There is… a striking mismatch between the traditional concern of regulators with issues of risk and safety, and that of the public, which centres on questions of moral acceptability [of biotechnology]… Conventional wisdom holds that knowledge is a crucially important determinant of support for science and technology – the more informed the public, the more likely it is to be supportive… [But] as already discovered by other industries trying to introduce controversial technologies (such as the nuclear industry), more knowledge does not necessarily lead to greater public acceptance.[3:25]

Some spokesmen for official agencies and for the bioscience industry reported, with no little frustration, that opponents of GE technology will not accept or believe even robustly authenticated information, unless it is compatible with their pre-established position on the issues. This view of the partisan nature of information also emerged in the focus groups – *if you are opposed to genetic engineering you will trust only the strident opponents* (N); *people will only trust information if it supports what they think* (I). And people raising concerns and objections to GE – such as the laypersons asking questions from the floor of the scientific experts at the recent ERMA Gene Technology symposium at Te Papa – often challenge the validity, assumptions and purposes of scientific and technical information.

But often, the issues are not about scientific evidence and authenticity *per se*, but rather about how the frameworks and the practical modus operandi of science can engage more effectively and more meaningfully with the other worldviews that are part of the overall spectrum. An extraordinary diversity of qualitative and not always tidily definable subjective influences have to be recognised and accommodated in the debate, alongside the available scientific information. These include values, personal beliefs, ethics, aesthetics, education, religious faith, culture and traditions, tikanga, the kaitiaki responsibilities of tangata whenua, the Treaty of Waitangi, socio-economic contexts, international contexts, and New Zealand's future commercial and export opportunities:

> Why should science, or the 'technical', be the language that decides what is or is not acceptable as we continue to manipulate various forms of life? There are… some issues at stake that are not adequately addressed by science – questions about the meaning of life, the purpose of the practices that are generated by science, and the place of humans in the wider world… Science can inform these issues, but science cannot answer them.[3:26]

> [T]o remain credible and retain public support scientists must contribute to discussions about the value and ethical content of their work. Moreover, scientists should be encouraged to see that they have a pivotal role to play in those discussions.[3:27]

3.17.2 Post-normal science

The concepts of post-normal science may offer useful perspectives on the tensions between scientific and other paradigms in the debates about biocontrols and GE:

> Science is normal when the uncertainty and the decision stakes (the adverse consequences) are small. The facts are hard and shared – the decisions relatively easy…
>
> The facts are softer where confidence in the new knowledge… may not be so widely held. Decisions are more difficult and can become suspect. If either uncertainty or consequence is high… the facts can be distinctly soft and the confidence almost non-existent. This latter category… is the realm of post-normal science.
> Of necessity subjectivity, and with that the values of the stakeholders, enter the equation. Judgement rather than reason

> prevails. The contribution of all the stakeholders is not merely a matter of broader, and usually superficial, democratic participation. The quality of the discourse, and thereby the judgement, is dependent on openness and inclusiveness, of information as well as people.[3:28]

The kinds of situations where post-normal science will be more appropriate and more effective than conventional scientific approaches have been identified as "problem situations" where "facts are uncertain, values in dispute, stakes high, and decisions are urgent".[3:29] The processes of post-normal science have been described as:

> a conversation among all stakeholders in a problem, regardless of their formal qualifications or affiliations… such a forum [should] be premised on free inquiry, without preconceived answers or agendas, but aimed at determining the envelope of knowledge and the magnitude of ignorance.[3:30]

3.17.3 Shifting worldviews

The extent to which individuals were able to change or modify their position in regard to such questions as potential applications of the new technologies, and those matters on which they were not prepared to shift, are important areas for further study. One of the focus groups (Levin community) had two discussion meetings, a week apart; this was intended (amongst other things) to explore the influences of the information provided, and the first discussion session, on the attitudes of participants. However the group reported no significant differences in individual participants' views and positions at the second meeting (see 1.3.2). The separate analysis of the focus group data (APPENDIX A) did not explore these issues in regard to the methodology trialled at Levin. It would seem a priority for any further work in community and sector-group responses to new technologies to address these questions, in order to build up a clearer sense of what kinds of information, understanding or experiences will affect and change the judgements and worldviews of different stakeholders.

3.18 Trust

Trust, or more specifically the lack of it, was an issue that spanned nearly all the focus group discussions and also featured prominently in many of the other meetings undertaken by the PCE's investigation team. Many of the stakeholders and interested groups engaging with issues of possum management and the wider biological sciences are deeply distrustful, suspicious, intolerant and dismissive of other players in the arena, and of any information, ideas or values those others might put forward:

> In an increasingly complex world, it has been said that trust is a functional substitute for knowledge. Particularly in situations of high uncertainty, lack of trust could become an important determinant of the way issues are viewed: in the absence of trust, perceived risks and moral dangers proliferate and appear greater.[3:31]

This corrosive deterioration of trust is the result of a gestalt of several inter-related factors. They include chronic communication failures, a perceived arrogance on the part of some key players, the histories of previous technologies and species introductions that had unforeseen and often tragic adverse effects, and the widespread perception that commercial imperatives are driving the development of genetic technology rather than more purely scientific, environmental or social goals. Often there is a blurring between the information and the issue, and the people or official agencies presenting or working with it:

> People are conscious that there is bias inherent in all sources of information, and they interpret it according to the characteristics of the source.[3:32]

> Lack of trust makes it particularly hard to communicate scientific information. Crucially, if people do not trust the person giving the message, they will not trust the message itself.[3:33]

> When most of us do not feel able to assess the risks ourselves, we tend instead to judge those that create the risks or regulate them.[3:34]

Studies on public trust of various sources of information and advice in regard to environmental issues and risks indicate consistently low levels of trustworthiness attributed to government agencies, corporations and the media; as a group, scientists ranked significantly more highly, and environmental organisations more highly again.[3:35]

The debates around biocontrols and genetic science have already become dangerously riddled through with negative stereotyping, demonising, and the attribution of unscrupulous agendas to different groups and parties – *the groups involved can distort the claims* (W). In many of the focus groups, hui and other meetings, and more clearly in the PCE's interviews with representatives of the various stakeholders, it was unavoidably obvious that these patterns of negative assumption have become solidly entrenched. The discourse often focused around the credibility and intentions of the respective parties, rather than actual questions about possum biocontrols and the possible application of GE to pest management. For many participants the polarised, adversarial character of the debate has already been set.

Resolution of this formidable impasse will require explicit acknowledgement of the sources of the problems, and a transparent, inclusive process for moving forward. A critical factor is listening – and hearing what is actually being said by others. Participants in complex, multi-faceted debates need to be open and willing to learn from each other, and develop mutual respect and understanding. But in adversarial situations where people are primarily concerned with getting their own messages and views across, they can sometimes miss out on hearing what others have to offer: "Communication of the risks associated with specific GMOs has been poor. This has resulted in a dialogue of the deaf…" [3:36]

3.18.1 Science

In a number of the focus groups, and with many of the other people consulted for this investigation, serious doubts were expressed about science in general, and the claims being made about genetic science in particular. This distrust was firmly based in the legacy of past scientific mistakes, accidents, and technologies where assurances had been given on insufficient evidence, with tragic consequences – *scientists have let us down* (P); *scientists have made bad mistakes in the past. This is why I'm worried about genetic engineering* (C). Examples cited by focus group participants included thalidomide, Agent Orange, breast implants, BSE, and RCD.

Another common component in the patterns of distrust of science, and scepticism about the beneficence of its applications, are the effects of the perceived (and in some cases actual) commercial orientation of today's research agencies – *CRIs are pro-GE because that's where they're getting their money from* (O); *universities have to make money now* (O). Although it was made clear in the focus groups, and other discussions, that New Zealand's current research into possum biocontrols is solely funded by the Crown, and is publicly accountable through formal scientific reporting systems, some focus group members expressed rather cynical assumptions about the profitability of such work and the career advancement goals of scientists involved in genetic research.

3.18.2 The industry

Biotechnology companies certainly are not trusted by many of the non-technical participants in the focus groups, and others consulted for this investigation. More than any of the other sectors in the GE debate, the large corporations were singled out as being driven by mercenary interests, rather than working for the greater public good - *pharmaceutical companies put profits above anything else* (P); *Monsanto trying to make money, trying to ram it down our throats* (M); *we've had a lot of research by corporations wanting to make a fast buck. The easiest bit about GE is working out how to do it, but there's no money going into seeing what the other effects might be, on the ecology. They're oriented toward results, not safety* (O).

Many of the activists, NGOs and ordinary New Zealanders who oppose GE and its possible applications have become entrenched in the view that genetic science and its associated industrial systems are irredeemably dishonest and inherently evil. The spectre of corporate globalisation, linked to genetic science through the dominance of big biotechnology companies such as Monsanto, was a frequent theme in the expressions of distrust and hostility in the

focus groups and other consultation. There was concern at the power and influence of multi-national corporations with vested interests in GE, and resistance to any perceived compromising of New Zealand's national autonomy in regard to decisions about whether or not to use the new technologies. The responses to IBAC's discussion paper on biotechnology reveal a similar lack of trust in the "role and motives of the business sector… [People] saw businesses being motivated by their own interest in profit only, with little or no consideration for the impact of their activities on the environment or vulnerable populations".[3:37]

The biotechnology industry views its products as offering extraordinary potentials, for sustainable agriculture, for human health, and to improve the quality of life. The Monsanto corporate motto is "Food, Health, Hope"; its corporate principles include commitments to "protect and enhance the ecosystems of the planet" and to "find breakthrough solutions to humankind's fundamental problems".[3:38] Its CEO has commented on the need for fresh approaches:

> At Monsanto, we're trying to invent some new businesses around the concept of environmental sustainability… Sustainability involves the laws of nature – physics, chemistry, and biology – and the recognition that the world is a closed system.[3:39]

The industry feels that the many opportunities offered by biotechnology are not given adequate profile in the present debates about GE. There is also a perception amongst advocates for GE that the public backlash is not about science, risk or the environment, as much as it is about hostility to large corporations. Some of the biotechnology industry representatives consulted for this investigation acknowledged the entrenched negativity of their public image. Monsanto was advised by its public relations advisers to refrain from making any public statements on any GE-related issues arising in the media or the public arena, and not to enter into any debate with opponents of GE.[3:40]

3.18.3 Government systems

Many people concerned about GE are fundamentally sceptical of government processes and agencies, such as ERMA. Some people consulted for this investigation perceive these systems to be ineffectual, providing inadequate scrutiny and safeguards, constrained by statutory or bureaucratic limitations, and to be unduly influenced by interested parties. However in contrast some individuals in the focus groups expressed their confidence that the official processes and structures would of necessity be robust and reliable.

In the fields of pest control and the development of biocontrol options for possums, the focus groups also revealed significant levels of distrust of the motives, activities and effectiveness of the official agencies. Here the focus of distrust was the current use of 1080 poison, as well as possible future proposals to use biocontrols. Examples of lack of trust include the (apocryphal) story raised in one of the focus groups, that individual ministers of the former government had commercial interests in the manufacture of 1080 baits, or the view expressed at the Mangamuka hui that government, in the form of the Department of Conservation, was perpetuating colonialism in its management of Taitokerau forests.

Regional Councils and DOC undertake extensive consultation programmes as part of the planning and preparation for pest control operations using current methods. Depending on the area involved, Consultation can include the public, stakeholder groups, neighbouring landowners, and tangata whenua.

3.18.4 Concerned citizens

The corporate interests, production sectors, and some in science and the official agencies are equally suspicious and scornful of the activists, NGOs and concerned citizens who are speaking out and challenging the kinds of directions that might be taken with genetic science and environmental management. One GE industry spokesman reported to the PCE investigation team the belief that Greenpeace, one of the leading groups campaigning against GE worldwide, was giving priority to this issue primarily because of the income it was generating in donations.

There is a perception amongst the biotechnology industry that the current public concerns about risk, and opposition to GE, are being fuelled by organised campaigns designed to generate fear, confusion and

suspicion. The investigation team also heard the view of some official agency managers, that recent opposition from residents to a 1080 possum control operation was only the result of the agitation of a few hysterical extremists.

Generally (although with a few notable exceptions) in the interviews conducted for this investigation, there was a pattern of condescension amongst the commercial and production sectors, and amongst some in the official and research fields, towards people and groups who challenge or oppose GE and technological approaches to pest control and environmental management. These opponents, and their views and arguments, tended to be distrusted and dismissed by advocates for GE as emotive, basing their arguments on perceptions rather than facts, lacking an adequate foundation in reliable scientific evidence, inconsistent, naïve and irresponsible.

However, the members of those opposing groups, and others concerned about biocontrols and other new technologies, see themselves very much as ordinary citizens, serious in their commitment to doing what they can to protect the environment, health, and the quality of the world we hand on to future generations. Some have minimal formal scientific education, yet debate intricate questions about DNA transfers, ecological effects, and risk; others base their concerns in advanced technical or medical training. Many are already keenly committed to environmental issues, conservation or organic production, and see their concerns about GE technologies as a natural continuation of these priorities in their lives. Many bring religious, philosophical and ethical foundations to their engagement with these technological issues. And for tangata whenua, there are a range of ethical and spiritual contexts and responsibilities (see 2.7.1, 2.7.2).

3.18.5 The media

For many participants in the focus groups, the media were a principal source of distrust, either because the media are perceived as vulnerable to manipulation by interested parties, or because of a perception that the need for "a story" would override the need to report the truth - *the media want an angle, you are trying to inform the public, but you are cornered into a media angle; the media don't want to know about the message, they want to know about the controversy* (E).
The nature of the news media at the turn of the 21st century must be acknowledged. Commentators on the modern media have made observations on media sensationalism, reductiveness, and orientation to conflict:

> [M]edia coverage is a murky business… every news story needs one or more of these elements – surprise, suspense, escape, intrigue, hope, contrast, conflict, drama… ethical dilemmas, excitement, and fear… In the list [of newsworthy topics] science ranked fairly low. It is seen as a complicated, arcane, long-term, cautious, minority interest. Worthy but dull. Essentially page four or fill-feature stuff.[3:41]

However, a number of magazines and specialist journals have in recent months featured articles and extensive in-depth discussions of GE, its possible applications, the risks, and the opposition (For example *The Economist, Time, New Scientist, Soil and Health.*)

3.19 A Continuum of Acceptability

Through the focus group discussions and other meetings and consultation for this investigation emerges, clearly and consistently, the concept of a spectrum or continuum of risk and relative acceptability for the different possum biocontrol methodologies outlined in the information pamphlet (Appendix C), and for biocontrols and GMOs in general.

Several of the groups recognised that there is a range of uses for genetic engineering – *people accept GE for medicines, but GE food has much lower acceptability. Biocontrol is somewhere in between* (S); *I'm all for a ban on GE food, but pro using it in human health research* (O). Amongst many focus group participants, there was a sense that GE is ahead of the public acceptability curve, or that the public is just not ready for some applications of GE.

A common distinction for many focus group members and other people consulted was the perceived extent of controllability of the technology – *letting something loose in the environment is very different from a contained use. If a contained use goes wrong it will affect very few* (N). The acceptability

continuum was based in the fundamental distinctions drawn between:

- work being undertaken in containment in a laboratory;
- a controlled field trial or application of the technology (i.e. organisms that are not self-replicating in the environment); and
- a general uncontrolled release into the environment.

Assessments of risk and acceptability are closely linked to concepts of how much predictability and control there is perceived to be for the technology, its particular applications, and its potential effects. Organisms that are understood to be highly unstable – such as viruses, commonly believed by the lay public to be uncontrollable, unpredictable and to mutate with daunting promiscuity – led to determinations of higher risk, and to emphasis on the importance of precaution, comprehensive trialling, and public information. There was considerable unease amongst some participants in response to the proposal that a self-spreading GM vector organism could be used to distribute a biocontrol throughout New Zealand's possum population – whether a virus or parasite spreading from animal to animal, or transgenic plants or trees growing in the landscape – *tests on other species are done in a controlled situation. Put it out in the environment and there's a whole lot of other factors* (W). There was deep concern that such technology would be indiscriminate, irreversible and, once established in the New Zealand environment, would be difficult if not impossible to eradicate – *once it's out there, you don't have a recall button* (O).

The concept of a continuum of relative acceptability is similar to other spectrum concepts advanced as possible models for dealing with issues surrounding GE, notably the option suggested by the Independent Biotechnology Advisory Council in its discussion paper, *Economic Implications of a First Release of Genetically Modified Organisms in New Zealand*, for:

> …discriminating between GMOs with different characteristics, that is, assigning GMOs into different categories… the first task would involve the identification of characteristics of a GMO, or its use, that would make its release acceptable or not. Some characteristics may be physical – for instance, the use of antibiotic marker genes. Some characteristics may be economic – for instance, the potential to impose costs on others growing the same export food product. Some characteristics may be ethical – for instance, the transference of animal genes into plants.[3:42]

3.19.1 Acceptability for different kinds of New Zealanders

Concern for the wider social dimensions of risk, perception and understanding was evident in many of the focus groups, the Wairarapa farmers' group, and with a number of the representatives of official agencies and the research industry consulted for this investigation. A pattern emerged where judgements on the relative acceptability of biocontrol technologies were attributed beyond the individual to some wider generic social grouping – many people identified the basis for their assessment of acceptability of biocontrols not in their own personal views, values, or experience, but in what they believed other people's levels of acceptability would be.

For some, these "once-removed" acceptability thresholds may perhaps have been rationalisations for personal preferences they felt unable, for whatever reasons, to express directly. Many people cited "the public" in general as not likely to accept a particular biocontrol method. Children were also mentioned as needing to be protected from awareness of unacceptably ruthless or unpleasant biocontrols. Men in some groups felt similarly that the women in their families would not accept pest control methods they saw as inhumane. And New Zealand's overseas markets were frequently cited as constraining the range of acceptability of pest control options, due to consumer sensitivities about both GE and poisons such as 1080.

For the Wairarapa farmers' group, there was a distinction between rural communities' direct understanding of the realities of possums in the landscape, and urban dwellers, who it was felt would principally respond to conservation priorities as an acceptable rationale for biocontrols. The Wairarapa farmers were pragmatic in their general acknowledgement of the power of urban consumers and overseas markets – regardless of the basis of consumer preferences, the markets are the bottom line. The group felt that unless the markets accept GE, it would make little sense

for New Zealand farmers to use such technologies – *the problem comes when we send our beef overseas, they will buy GE-free beef rather than ours with 'grown in NZ with GE biocontrols' – I'm governed by what people think of my products* (Wairarapa farmers).

3.19.2 Beyond the continuum

Despite acknowledgement from many focus group participants that some applications of genetic engineering technology might be acceptable, there were some participants who suggested that genetically engineered possum biocontrols might be a "Trojan horse" that would encourage wider acceptance amongst New Zealand society of other kinds of applications of this technology - *GE for possum control is about getting the foot in the door for GE for food, to reassure us it's safe* (P); *When you allow GE for possum control, that says to the New Zealand public, 'look at this wonderful tool for controlling possums', they think perhaps it's not so bad if we have it in our food, or crops grown in the environment* (O). For representatives of the biotechnology industry and some pest control managers, however, there was concern that releasing a GMO such as a biocontrol, if the public is resistant and there is a backlash of opposition, may jeopardise the future of other applications of GE technology in New Zealand.

Box 9: The lessons of nuclear science

The comparison is sometimes made between genetic science and nuclear technology, between the claims made in the GE debates of today and the claims made for nuclear energy in the 1950s. Perhaps the analogy is also relevant in terms of questions of controllability and containment. In most countries, non-military uses of nuclear power are extensive, though not expanding. The extraordinary risks and dangers of this technology have, since Hiroshima and Nagasaki in 1945, become more apparent with increased experience of application; nuclear technology can now only be utilised under the strictest and most stringent containment and protective systems. When nuclear management systems fail, and containment standards are breached – as with Chernobyl in the Ukraine, the recent Japanese nuclear material reprocessing accident, or the discovery of misreporting at Sellafield in Britain – there is crisis, tragedy, and public outcry. Will the applications of genetic science also come to be acceptable only when kept sealed away in a secure facility, under sufficiently tight conditions and restrictions that the levels of risk are considered tolerable?

3.20 Decision-making Processes

Participation of the public, of tangata whenua, and of interested parties and groups, in decision-making processes for the development and use of biocontrols were important issues for several focus groups, the hui and other meetings with iwi representatives, and others consulted. The concerns centred around the need for appropriate channels and systems, so that as wide a range as possible of interested and concerned people would be able to participate - *it's a national situation, we should all get involved in the decision* (M); *the people who have an interest in this aren't just the people who have a problem with possums, we all have an interest in this* (O). Tangata whenua, concerned citizens opposed to GE, and a number of focus group members emphasised the importance of systems that would reliably provide recognition and respect for their input, views and values – *people want... to feel that their beliefs and ideas are having some influence* (E).

There was some consideration in the focus groups and other consultation of the roles that scientific experts and government should play in the overall decision-making process. Other commentators have considered these issues:

> As Robert Oppenheimer made clear in relation to the bomb, the duty of scientists is to understand how the world works; but how this knowledge is used ultimately lies, in a democracy, with the people's elected representatives… The way scientific knowledge is used raises ethical issues for everyone involved.[3:43]

Concerns about the role of science included the expectation that information on technical, scientific and risk issues would be provided – as the necessary basis for people to make robust, informed decisions – by a disinterested source. Some focus group participants and others consulted for this investigation expressed general scepticism about the neutrality of scientific research institutions or government agencies (see 3.18.1–3.18.3). However, a proportion of people had confidence that formal processes established by government agencies would be conducted responsibly, properly and fairly, and had faith that the statutory frameworks would provide appropriate systems and safeguards to ensure public involvement.

A number of people and groups cited problems they had experienced in their own efforts to engage with the existing regime. In particular, some iwi and hapū representatives, and members of the two focus groups consisting of ethics experts and opponents of GE, had direct familiarity with the ERMA systems set up under the Hazardous Substances and New Organisms Act 1996 to regulate the testing and release of genetically modified organisms. (see 2.6.4.1 and 2.9.5-2.9.7). There was frustration with the constraints and limitations imposed on ERMA's process as a consequence of its statutory framework allowing only a case-by-case approach to assessing applications – *ERMA's remit is a bit narrow* (E); *ERMA has said they are there to administer the Act, not to look at the bigger issues. And it's the bigger issues that the public are concerned with, not the technology but its consequences* (E).

There was also significant concern about the extent to which such processes as that set up by ERMA, no matter how thorough or formally correct, are capable of recognising and accommodating many of the kinds of concerns people are raising in regard to GE and other new technologies such as biocontrols. A perceived orientation towards scientific, technical data as the basis of assessments of risk and acceptability left considerable concern about the adequacies and comprehensiveness of such systems – t*hey ask for specific technical reasons why you're opposed to things, they're not considering spiritual and ethical reasons* (O).

Tangata whenua representatives cited their experience with cases such as the high profile application for GM cattle incorporating human genes, which after vehement opposition from Te Kotuku Whenua and Ngati Wairere, underwent an extended consultation process. ERMA's Maori advisory committee, Nga Kaihautu Tikanga Taiao, and the Maori member of the Authority's decision-making committee, recommended against the application. But the Authority recently granted approval for the cattle research project .[3:44] The application was approved with conditions, and has now been appealed; Nga Kaihautu initially registered its interest in the appeal but subsequently withdrew. [3:45]

3.20.1 Representation

Representation and the range of skills, backgrounds, knowledge and experience of the members appointed to official decision-making bodies were matters of concern raised by a number of groups, tangata whenua and individuals. Indeed these kinds of issues arose at one point within the PCE's Reference Group for this investigation, when one of the non-technical members expressed strong feelings about the composition and orientation of the Group, feeling that it was heavily weighted with scientific experts and advocates for biocontrols. There has also been dissatisfaction with the range of representation of different sectors amongst appointments to IBAC and more recently the Royal Commission of Inquiry into Genetic Modification. People from NGOs, concerned groups, tangata whenua, and also (in regard to the Royal Commission) from the commercial and industry sectors, will have diminished faith in a process when they perceive that their concerns, values and interests may not be adequately represented or understood by the official decision-makers. These dimensions of the processes were also mentioned in some of the focus groups, with the view that there needs to be trust in the individuals involved in decision-making and policy development, as well as in the process itself — *[need] absolute confidence that people making the decisions on your behalf are doing it ethically* (W).

Many of the focus groups, and others consulted for this investigation, emphasised the importance of re-establishing public trust in the official processes, and debated a range of avenues for doing so. Of central importance was the need for open and transparent decision-making processes - *people need to have confidence in the*

process, how is the decision being made, rather than a need for trust in the person making the decision (E); *needs to be transparent* (M); *no hidden agendas* (P). In the group of Wairarapa farmers, it was suggested that a critical factor is adequate time for decision-making processes, so that all the necessary information could be obtained and considered, and the full range of risks identified and examined – *we need a slowing down of the decision-making process to get a better understanding of what the effects are, what the options are* (Wairarapa farmers). Tangata whenua also consistently insisted upon adequate timeframes for consultation and decision-making processes, so that the issues can be thoroughly discussed within the iwi, hapū and whanau, the relevant information and background can be assembled, and the assessment appropriately conducted in accordance with tikanga.[3:46]

3.20.2 Public Participation

A range of possible methods for public involvement in decision-making about the use of biocontrols was discussed in the focus groups and other consultation meetings. An important principle emphasised by an iwi representative is that the process needs to be proactive in going out to reach ordinary New Zealanders – local communities at events and gatherings, at the pub or the dog show or the kids' school sports day, farmers, mothers, working people, teenagers, retired people, the full spectrum of New Zealand society. There was a concern that official policy processes tend to rely on particular groups or individuals who have a profile, or are already involved in such processes, and that to genuinely provide for and reflect the views and concerns of the public, a much wider and more egalitarian kaupapa is needed.

A frequently mentioned process for public participation was a citizens' referendum – this method was perceived as allowing maximum democratic inclusiveness in that every New Zealand voter would have equal opportunity to express his or her views. However, it was noted by a number of focus group members that to be meaningful, a referendum would need to be preceded by a comprehensive information campaign to ensure adequate public understanding of the full range of issues involved. It was also noted at the Mangamuka hui that the options put forward in any referendum would need to be very clearly and carefully framed and worded to avoid confusion.

Concepts of participatory systems such as "civic science" emerged at the end of the 20th century. These kinds of processes:

> …call for a meditative science-policy relationship, the nurturing of communicative and arbitrative mechanisms at early stages in dispute resolution, and [giving] both the Earth and marginalized groups in society some space to breathe in the application of environmental policies. These… approaches seek negotiable interchanges between citizen and expert to create consensus… The opportunity exists for science to reach out into more democratic structures so that the possible consequences of various courses of action can be given greater understanding and due political weight.[3:47]

> Deliberation on risk… should be an inclusive and informing process, part of a democratic society, in which affected parties and others have the opportunity to be part of the framing of the questions and the formulation of the definitions of the issues at stake. This requires recognition of a range of constituencies of interest…

Three compelling rationales for broad participation in risk decisions… are:

- participatory democracy and the need for the consent of the governed;
- that there is much wisdom and knowledge in the community which can provide insights, problem identification and information that the 'experts' are likely to miss;
- the process of participation may increase acceptability of decisions, improve trust in the agencies involved, and diminish conflict.[3:48]

The VALSE project is an international research programme exploring the ways that concerned populations express the different kinds of values in the environment. Working from a principle of complexity, or "a multi-dimensional perspective reflecting the variety of scales over which a problem may be considered and the range of individual and collective interests that may be involved",[3:49] the project develops an understanding of citizens' values, interests, and involvement in environmental management through four case studies – the Bois de Bouchereau woodlands in France, water management in the Canary Islands and in Sicily, and fen wetlands in East Anglia. Participatory methodologies as well as the values frameworks of each case study's communities of interest are assessed.

3.21 Information and Knowledge

From the detailed biocontrol-oriented discussion in the focus groups, and the wider context of consideration of the new genetic technologies and their potentials and risks, a consistent demand is for more information. Many people felt they did not yet have enough knowledge and understanding to be able to engage effectively with the complex issues surrounding biocontrols and GE, and work through to a decision about its applicability in particular circumstances. Most participants in the focus groups and many others consulted stated both that they wanted more information themselves on issues of biocontrols and GE, and that the wider community should have more information provided on these matters, and should be kept regularly informed. The importance of environmental education was emphasised in one group – *environmental education must be an essential part of the curriculum, going into every school* (C). These concerns are reflected in a recent nation-wide survey of rural and urban New Zealanders which, in response to questions about genetic technology, found "overwhelming agreement… that there has not been a reasoned, well informed debate on genetic modification and the issues involved. Amongst urban New Zealanders only 19% believe there has been a reasoned, well informed debate, and amongst rural new Zealanders 17%".[3:50]

The provision of information was seen as important for several reasons. There was a strongly held principle that the public has the right to know about developments, technologies, issues and events that will or might affect them – *people should know what's happening* (W). Another strong argument for information programmes was the opportunity to build public understanding and acceptance of new technologies in the long term – *take people along with you, while doing the research, so they are more likely to accept it* (S).

While the expressed need for information and informed public participation was common across several groups, there was also recognition that not everyone would utilise the information or get involved in the decision-making process – h*ow many people are going to look at a website?* (M); m*ost people would put junk mail in the bin* (W); *New Zealanders don't take any notice of something unless it's on top of them* (S).

Furthermore, information was seen as only part of the solution (see 3.17). Public perceptions and values on issues like GE span a wide spectrum: "the statistical probability of harm as determined by an 'expert' is but one element used by the public to evaulate potential dangers".[3:51] There is a need to develop systems that acknowledge the place of information in amongst these other dimensions of acceptability, risk, values and ethics, and incorporate them into the assessment and decision-making processes – *the assumption that, by educating people, everyone is going to come out with the same idea, is incorrect. You will still get a range of opinions and have to deal with that* (E); *half the population won't change their minds, no matter what you tell them* (M). One focus group insisted that informing the public wouldn't be enough, and that engendering active debate would be critical – *we have a duty to inform the public and provoke public discussion and, even if people don't want to think about it, they should be encouraged to* (E).

3.21.1 What information is needed?

Although there was general agreement through the various consultation for this project that information will be critical, it was less clear for many people just what kinds of information are needed? Which aspects of the science and its potential applications are most important for people to learn more about? What levels of complexity and scientific specialisation will be appropriate, accessible and relevant in the New Zealand context? These kinds of questions were directly evident in this project, in the writing and production processes for the information pamphlet (Appendix C) that was to be the basis of the focus groups and other discussions. There were different expectations from scientists and non-scientists about what sorts of knowledge would be necessary for laypersons to take part in the project, and what levels of technical information (for example, the physiological workings of the immune system or the possum's conception processes) would be the basis for focus group participants to make their assessments of the proposed technologies. In the end it was decided to keep it as simple and straightforward as possible; a more detailed version of the

pamphlet (Appendix D) was made available at the focus group sessions for people to follow up the issues in greater depth if they wished to do so.

From the range of views expressed in the focus groups, and the other consultation undertaken for this investigation, four key areas can be identified where there are critically patchy levels of public awareness and information. These are:

- the extent of the possum problem – thus the reason why any of these technologies are being considered;
- the technical aspects of the biocontrol science itself;
- the areas of ethics and values, and the cultural, philosophical and religious dimensions of human intervention in the genetic structures of other species; and
- the processes for research and approval of proposed applications.

3.21.2 What information is available?

Many individuals and groups have worked hard to make themselves more thoroughly informed on genetic engineering issues and in some aspects of the possum and its management. Many laypersons are very knowledgeable about pest control technologies and the associated issues. Many people in both rural and urban situations have considerable close "hands-on" experience with possums and their effects on the environment (and the roses). And many professionals in particular areas have extensive resources of information and expertise on which to draw.

Official agencies as well as NGOs and interested groups have organised conferences, presentations and seminars to provide information on GE issues. ERMA has held several public events and annual conferences, all well attended by a wide range of stakeholders and interested members of the public. Other groups such as the New Zealand Soil and Health Association have, at national conferences and other gatherings, addressed GE and related issues such as organics futures. The International Science Festival in Dunedin in July featured a screening of the movie "Gattaca", an Orwellian story of a future world based on GE, followed by a panel discussion of scientists and commentators. Some local authorities, such as the Christchurch City Council and Hurunui District Council, have addressed GE issues in special seminars and public discussion forums.

Two Talking Technology Forums were held in New Zealand in 1996 and 1999. This is a consensus conference process based on a Danish model, focusing on a technical issue that has the potential to impact upon society; members of the lay public are briefed by experts, debate the issue and produce a report. The New Zealand Forums concentrated on plant biotechnology and genetic engineering. Their conclusions include recognition of the impossibility of "cast-iron guarantees that this technology will not have an adverse effect on the environment", endorse a conservative approach to the implementation of plant biotechnology, and identify "a deficiency in public awareness and education, in regard to the technology and its effects, that needs to be addressed".[3:52]

There is an increasing amount of published material in New Zealand (see Bibliography). The Independent Biotechnology Advisory Council has published two discussion papers on GE. A recent independent publication, *Designer Genes*, is a useful collection of essays on a wide range of GE topics. Starting with a basic "beginner's guide" to biotechnology, the collection includes articles on GE food, crops and medical applications, New Zealand's future exports, environmental effects, ethical and spiritual dimensions, and a Maori response to the biogenetic age. Bringing together pieces from across the spectrum of perspectives on GE, *Designer Genes* sets essays by proponents of the new science alongside statements of criticism, concern, fierce outrage and firm opposition, for the reader to make up his or her own mind.

There is also a well established body of published material on possums, pests and their management in New Zealand. Two of the more recent reports are noted here. The New Zealand Conservation Authority commissioned a report looking at the wider context of pests and weeds in New Zealand, *Pests and Weeds: The cost of restoring an indigenous dawn chorus: A blueprint for action against the impacts of introduced pest organisms on the New Zealand environment*. Landcare Research has recently published a collection of technical and discussion papers, *The Brushtail Possum: Biology, impact and management of an introduced marsupial*. Covering such matters as possum feeding

Table 2: Information Requirements

1: Possums:
• The extent of possum infestation and the impact that possums have on biodiversity and agricultural production in New Zealand; • The risks possums pose and the hard choices New Zealand has to make regarding the costs of possums to our ecology and our economy; • The physiology and life processes of the possum – how long do they live? How often do they breed? What is the development process for a joey in the pouch? How do they associate with one another in the wild? How quickly do they recolonise an area after a control programme has reduced their numbers? How low does their population density have to go to limit the spread of disease, notably bovine Tb? • The organisation and assessment of current possum controls, the official systems and strategies under which this work is being carried out, and the effectiveness and achievements of these programmes against their stated goals; • The current toolbox of control techniques, and the often extensive range of practical, operational and administrative requirements that are necessary for these methods of possum control to be effective – these aspects range from the small-scale hands-on information of how to set and clear a Timms trap, through to the complex logistics and demands of running professional teams of possum trappers, which include training and certification, bush skills, motorbike or 4WD skills, project management, and community consultation; • Why using biocontrols, especially genetically engineered options, is necessary or advantageous; • Alternative methods for controlling possums (such as biodynamic methods), their environmental impacts and effectiveness, and the potential benefits and risks of these other kinds of methods and technologies.
2: The technical aspects of genetic science and biocontrols:
• Information about genetic technology – how does it work? How is it defined? How is it done? What kinds of effects might it have by targeting particular processes in the target species? What is the fate of genetically modified cells when a GM animal dies and its body breaks down? If a plant is genetically modified, what if any are the actual or potential implications for any species that feeds on the modified plant? • Information about these particular biocontrol methods, their intended effects on possums, and their effectiveness – would the immunosterilisation or immunocontraception be permanent or temporary? If only temporary, how long would it last before reinfection would be needed? How many possums would be rendered infertile in the overall population? Would they develop immunity? • Information on the risks and possible unintended effects and consequences of the biocontrol methods – will it mutate and, if so, is it likely to have any unwanted effects? How fast and how far would it spread within possum populations? What factors might limit or constrain its potential for adverse and unpredicted effects? What might increase such potentials? What might be done to minimise risk, and avoid, remedy or mitigate any possible adverse effects? • Information on the testing and trialling that needs to be or has been undertaken to give assurance about such potential effects, and information on the research processes, peer reviewing and checking, and approval systems for New Zealand researchers in these new technologies.
3: Values, ethics, and cultural dimensions:

• In a GE context
  • information on the values and perspectives of tangata whenua in relation to natural taonga, systems and environments,
  • information on the rights of iwi and hapü under the Treaty of Waitangi and the statutory provisions and legal findings in regard to those rights and the management of taonga, and

- an appreciation of the responsibilities of kaitiaki to past and future generations to ensure that taonga are managed wisely and appropriately and handed on in good health to the next generation;
- Information on the ethical and moral aspects of the development and introduction of new technologies, as outlined in the commissioned paper by Mark Fisher (see Appendix B);
- Information about animal rights and animal welfare, about the legal requirements and regulations governing our treatment of animals, and about the work and philosophies of campaign groups for animals such as SAFE;
- Information about New Zealand's unique biodiversity heritage, the extraordinary Gondwanan remnants surviving only precariously on these islands, and our responsibilities and commitments under international treaties (notably the Convention on Biological Diversity and the Biosafety Protocol) to protect and sustainably manage them;
- Reliable information (rather than generalised assertions whether optimistic or intimidatory) of the economic implications of possible use and non-use of proposed control technologies – what would the figures be within New Zealand, with the ongoing financial burdens of current pest management and possum damage? Is a possum fur industry a seriously viable option or just a grand gesture towards the rural unemployment statistics? What would the figures be for the possible effects on New Zealand's economy and the markets for our exports, either in having genetically derived biocontrols applied to possums, or not using GM options? How would the costs of any unforeseen consequences of a GE biocontrol be met? Or compensation, if the worst-case scenario does happen?

4: Research and approval processes:

- Information on the work and structures of the research institutes and other science agencies;
- Information on the allocation of funding for research, and the criteria and priorities established by FRST for such work as possum biocontrols;
- Information about ERMA's processes for assessing and approving applications for new organisms;
- Practical information about the kinds of systems and safety measures involved when research has conditions imposed that it be conducted in containment, or in contained field trials;
- Information on the statutory and regulatory frameworks (see 2.9.3-2.9.7).

patterns, activity patterns and social behaviour, population structure and dynamics, bovine Tb, conservation impacts, control methods including non-toxic techniques, and economic analysis, the collection is intended as an authoritative reference work on everything you need to know about possums.

3.21.3 Trusted information – who should provide information?

The partisanship evident in much information on GE issues is an ongoing and not inconsiderable difficulty for resolution of the issues surrounding the potential use of biocontrols for possums. Questions about the authenticity of information, its comprehensiveness, and the credibility of information sources, often cloud the issues with confusion and further uncertainty. When scientists have differing interpretations or judgements on a project, proposal or wider area of research, these differences can, in the media or in the campaigns of particular groups or sectors in the debate, be built up into scenarios of conflict and confusion – *Federated Farmers and Forest & Bird counter each other's arguments. The person in the street doesn't know who to believe* (I). This can be damaging to public confidence in science generally, as well as intensifying doubt and resistance to that particular technology and its proponents.

One critical factor in the overall GE debate, and in the shifting trends of public perception and opinion, is the timeliness of information. The advancement of GE science and technology is marked by very rapid rates of progress, using global internet-dependent networks, with teams of scientists contributing from agencies and institutions all around the world. In an arena where research findings, new data and new proposals and innovations are continually coming through, information must be up-to-date to be meaningful. When that arena is also influenced by a regular flow of political statements, campaigns and tactical positioning exercises undertaken by the respective interested parties, the need only intensifies for close monitoring of the news and timely information.

3.21.4 How information is communicated

The ways in which information is communicated are as important – both for levels of understanding and for acceptance and trust – as the content. There are a wide range of ways in which information and ideas about biocontrol technologies and GE science can be conveyed:

- in the conventional publication systems of scientific institutions and systems;
- in the news media;
- in public forums, such as the recent ERMA symposium;
- in hui on the marae where tangata whenua can assess the issues within a framework of tikanga and kawa;
- through structured learning processes such as the Talking Technology conference model, or the suggestion of "a series of policy panels… [with] the opportunity to interact with experts… in a forum environment or as a Delphi process (involving an iterative series of surveys of experts) that would allow the public to frame the questions to which the experts would respond";[3:53]
- in schools' science curriculum work, and the educational programmes of science agencies;
- in kōhanga reo and kura kaupapa;
- on the internet, which has two advantages:
  - immediacy of information, and
  - a wide range of sources and providers of information and opinion from which to select, including extreme and partisan viewpoints, authoritative academic research, and the wild and eccentric sites (such as those from the southern US offering recipes for gourmet possum goulash);
- face to face meetings and discussions, such as the small-scale focus groups organised for this investigation;
- creative ways of utilising the media, such as:
  - snappy soundbite-sized chunks of information dropped frequently into prime-time programming on TV or radio,
  - equivalent small "info-chunks" and images featuring regularly and prominently in newspapers or popular magazines,
  - campaigns, special events, festivals and celebrations,
  - developing a storyline around the issues for a mainstream drama such as *Shortland Street*,
  - creative performance projects such as a ballet, musical composition or concert addressing the issues,
  - TV programmes devoted specifically to New Zealand environmental issues,

> and/or a dedicated Maori environmental programme, with regular features on te taiao and kaitiakitanga, and news of practical developments in environmental management.

There are a range of communication and educational methods, each with different strengths and limitations for different audiences and groups in society. But whichever communication tools are used in the process of informing New Zealanders about GE, biotechnology and possum biocontrols, a strategic framework, focus and accessibility are key principles.

There is no sense of any overall strategic directions or any guiding framework for the processes to provide information on GE and its possible applications in New Zealand. There is not yet an established structure for the necessary debates to work through the issues and the controversy. However, the deliberations of the Royal Commission will help to develop such a kaupapa.

Within the necessary overarching strategic framework there will be a need for greater focus, precision and purposefulness in regard to the actual information and messages being communicated. Much of the current debate lacks sufficient clarity to result in significant improvements in New Zealanders' understanding and engagement with the issues.

The principle of accessibility is fundamental. Formal modes of presenting information (for example, the academic structure for a scientific paper) are appropriate in specialist fields, but will not be helpful for the wider public. Information needs to be provided in plain, direct language and format. Visual images will help convey complex matters to non-specialists.

Few scientific research professionals or technicians have the training, skills or aptitude to develop and provide appropriate public information programmes. Few communications experts are sufficiently knowledgeable and involved with the advancing technology. This is a critical area where proactive initiatives need to be taken within the relevant research agencies and universities, to establish communications training, contract in the necessary educational and media advice, and improve the skills and awareness of scientific researchers in these areas:

> Although we must train our… scientists to present their data accurately and honestly, we must also teach them to present their science with enthusiasm and wonder. After all, science is awesome… scientists must spend more of their precious time communicating their work to the public.[3:54]

An examination of the science communication programmes within CSIRO (Commonwealth Scientific and Industrial Research Organisation) Australia would be a useful starting point. That organisation has established dedicated programmes and actively researches the interface between science and society. The US National Science Foundation has also, in its work on public attitudes and understanding of science and technology, undertaken as part of a programme on Science and Engineering Indicators, assessed the relationship between science and the media. The NSF study found that: "The science community and the news media are missing opportunities to communicate with each other and the public", and identified critical problems including scientists' distrust of the media, a perceived lack of public interest in science, and communication barriers.[3:55]

There are strong opportunities in bringing together teams of people with the expertise and skills from different disciplines and fields to work collaboratively, combining their knowledge and their respective approaches to the science, the issues and to the processes of communication. The PCE's project itself should be seen as an example of the synergy that can be possible with the contributions of research scientists, social scientists, tangata whenua and the wide range of people on the project's Reference Group.

3.22 Research

Within the more general considerations of information requirements, some focus group participants and others interviewed for this investigation discussed particular requirements for research. Areas covered in these discussions included:

- the kinds of scientific research that participants considered would be necessary to give assurance of safety and other acceptability criteria;
- methods for more effective communication of scientific information and developments; and

- the decision-making processes governing the movement of science from the laboratory out into the environment.

Many people in the focus groups insisted upon research being undertaken over a sufficiently long term, as a prerequisite for acceptance of biocontrol technology and its release into the environment – *if the research is done right and they are proven* (M); *need long-term research, two or three generations of possums as a minimum* (P); *we look for quick fix solutions, we don't give them the time to measure the effects down the track* (P).

Several groups discussed specific areas that people considered should be priorities for biocontrol research. These included:

- practical matters – how the technology would actually work, effectiveness, delivery systems, the dose required to infect animals, the best season for releasing the biocontrol, residual effects in the environment, possible suffering to the possums;
- ecosystems, the relationships between species, the impacts of pests (all pest species), biodiversity recovery processes after pest control operations, and impacts on long-term evolution of ecosystems;
- monitoring systems, to track the effects and impacts of a biocontrol after it has been used;
- matters of risk assessment, including possible future effects, cross-species risks, potential for possums to develop immunity, potential for mutation of biocontrol organisms, and risks to Australian wildlife;
- funding requirements over the medium to longer term (will there be surety of funds to make the research worth starting?), and full costings of different options, to provide a robust basis for decision-making; and
- techniques of public communication and factors involved in public acceptability – *how you take the public along with you* (S).

Notably, despite the widespread concerns about the development and possible effects of the new technologies, none of the focus groups, hui or other people consulted for this investigation said that they wanted to halt research altogether. For some, there was a sense that New Zealand cannot afford to foreclose on any research options that might deliver useful tools to help deal with possums – *we can't decide whether it's worth researching until we have done the research* (C); *for GM food and biocontrol, keep it in research* [the laboratory]*, not in the field* (O). This support for research is closely linked with the acceptability continuum, where acceptability decreases as one moves from containment to field trial to release (see 3.19).

As well as the scientific and technical research areas, there was strong support from many of the people consulted for this investigation for further research work to be done into the social dimensions, including acceptability, values, ethics, cultural frameworks, risk perception, and communication issues. There are a range of methodologies which could be useful for the closer exploration and analysis of acceptability on difficult, complex issues such as biocontrols or genetic technologies. These include:

- further focus group discussions;
- public opinion surveys, which would be necessary for quantitative data;
- the traditional protocols of hui on the marae, where tangata whenua debate an issue and determine an appropriate response;
- citizens' jury models involving community representatives to decide between different policy options;
- consensus conference processes, where a group of people investigate the particular issue and work through to a set of conclusions (see 3.21.2);
- Galileo belief mapping, a process that depicts graphically the ways people view complex issues and the interrelations between the parts of a complex belief system, and which can be used to monitor changes in beliefs and attitudes over time; [3:56]
- sensitivity mapping techniques combining quantitative and qualitative factors in the appraisal process; or
- multi-criteria mapping, a system that ensures inclusion of the entire spectrum of values and interests in risk assessment processes, and identifies crucial framing assumptions and the ways in which they determine and influence those assessments. [3:57]

3.22.1 Current projects

Some research work is already being undertaken in New Zealand, in both the social and technical areas. The Foundation for Research, Science and Technology has allocated $408,000 for the 2000/01 year, increasing to $700,000 for 2001/02, for research to:

- determine potential key effects (beneficial and adverse) of different kinds of genetically modified organisms and GMO-related biotechnologies that may be released and/or used in Aotearoa/New Zealand… [to] help people and organisations understand, analyse, weigh up and draw conclusions about such effects;
- determine key factors that influence acceptability of such technologies, with particular attention to socio-cultural factors, including tangata whenua values; and
- develop ways of integrating these two research themes through development of frameworks or processes to contribute to robust decision-making and policy development in this area.

Landcare Research is working with PGSF funding to develop a risk profile for New Zealand natural ecosystems, within a biosecurity programme studying invasive invertebrates. This risk model recognises that invasion processes are multi-faceted and often taxon and place specific; thus it is necessary to integrate a wide range of data in a flexible analysis framework to produce spatially-explicit predictions, and assess an ecosystem's vulnerability to alien invasive species.

The AgResearch Biocontrol and Biosecurity Group is undertaking a PGSF-funded programme into "Improving the Environmental Safety of Biological Control", with the goal of improving decision support systems for environmental managers by being able to make more accurate pre-release predictions of a proposed biocontrol agent's host range and impacts on non-target species. AgResearch is also, in association with HortResearch, undertaking an extensive new PGSF-funded study of "Environmental Impacts of New Technologies". The aim of this programme is to determine the environmental safety of new biotechnologies such as genetically modified plants and biopesticides, by investigating their multi-level impacts on ecosystems and secondary organisms, and looking specifically at the longer-term implications. The study will develop a risk assessment and system modelling approach to environmental impact assessment, and a hierarchical testing procedure for new organisms. The researchers will also explore areas of ongoing and emerging public concern over GMOs and other new technologies, report on key interest groups and effective communication methods, and seek to raise awareness of environmental impacts issues within the science community.

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3:4 PCE 1998: *Kaitiakitanga and Local Government: Tangata Whenua Participation in Environmental Management*. Wellington.

3:5 HRH Prince of Wales, Lady Eve Balfour Memorial Lecture, London, 19 September 1996.

3:6 B Nicholas 1999a: Beyond Safety: Value-Added Science. *Food for Thought*. National Agricultural and Horticultural Science Convention, Auckland, p 8.

3:7 B Nicholas 1999b: Making decisions: making the world. *Innovation, ethics, and animal welfare: Public confidence in science and agriculture*. Proceedings of the joint AWAC/ANZCCART Conference, Wellington, New Zealand, 18-19 November 1999, p 108.

3:8 Australia/New Zealand Standard, AS/NZS 4360: 1995.

3:9 This list bring together points from various sources in the extensive literature on risk assessment – for example, the papers gathered in the 1998 edition of the *New Zealand Science Review* from the conference on *Risk Assessment: Perception and Science.*

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3:11 D MacKenzie. Sick to death. *New Scientist*, 5 August 2000.
3:12 Nicholas, 1999b, p 109.
3:13 M Tweeddale 1998: Risk Assessment and Reality. *New Zealand Science Review, Risk Assessment: Perception and Science Conference Issue 55*, 1-2, p 8.
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3:20 For example: *Attorney-General v Geothermal Produce New Zealand Ltd* (CA75/83, CA82/83) 28 May 1987.
3:21 *Relk Holdings Ltd v Manawatu-Wanganui Regional Council* (CA86/93) 1 June 1994.
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3:23 For example: L Wolpert 1992: *The Unnatural Nature of Science*. Faber; L Wolpert and E Goldsmith 2000: Is Science Neutral? *The Ecologist* 30, 3; R Lewontin 2000: *It Ain't Necessarily So: The Dream of the Human Genome and Other Illusions*. Granta; and Genes, Environment, and Organisms. *In*: R B Silvers (ed) 1995: *Hidden Histories of Science*. Granta; M Cross 2000: The Truth is Out There. *New Scientist: Inside Science 128*; R Sullivan and A R Hunt 1999: Risk Assessment: the Myth of Scientific Objectivity. *Environment and Planning Law Journal 16*, 6, pp 522-530; S Inayatullah and J Fitzgerald 1996: Gene Discourses: Politics, Culture, Law, and Futures. *Technological Forecasting and Social Change* 52; Laura Nader (ed) 1996: *Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge*. Routledge; F Capra 1982: *The Turning Point: Science, Society and the Rising Culture*. Collins; S J Gould 1981: *The Mismeasure of Man*. Penguin; A W Crosby 1997: *The Measure of Reality: Quantification and Western Society*. Cambridge University Press.
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4. CONCLUSIONS

This investigation had its origins in concerns about the way science and science investors interact with society during the development of new biocontrol technologies for use in the natural environment. The polarised debates that surrounded the proposal to introduce the RCD virus for rabbit control were clear evidence that something was seriously wrong at the interface between science, regulatory agencies and communities.

The study therefore set out to explore the interactions between science and communities in terms of views about a range of possum biocontrol options, most of which involve genetic engineering, that are currently being researched in New Zealand.

4.1 Possums and Biocontrols

4.1.1 General issues

There is wide recognition of the need to deal effectively with New Zealand's possums and their impacts on our environmental and economic sustainability. The urgency of this imperative, and the possibilities offered with new technologies, demand robust evidence of the safety, effectiveness and controllability of those technologies, and a comprehensive process of public involvement to ensure the full range of values and concerns are addressed (see below).

It is significant that biocontrol technologies for possums are as yet early in the development stages and while they show promise, they are some years away from being ready for possible application. The advantage of this is that there is still time for New Zealand to develop a strategic approach to such technologies, to gather input from the public, tangata whenua, and groups and sectors with an interest, and to address the many issues and knowledge gaps identified.

There is also recognition of the need for additional methods of possum control, although the interest in new technologies is counterbalanced by strong support for utilising our current "toolbox" of control methods more extensively and more effectively. There is interest in biocontrol methods which may offer practical assistance to help deal with New Zealand's possum problem. However the fact that most of the methods currently being researched will involve genetic engineering, or a genetically modified organism as a delivery system for the biocontrol, significantly increases the levels of public unease and perceptions of the potential risks of these technologies.

Interest in the possibilities of biocontrols is tempered by deep concerns about GE across a range of inter-related fronts, including ethical concerns, cultural issues and Treaty of Waitangi implications, concerns about the distribution of risks and benefits, and questions about safety and potential unforeseen effects of genetic technologies. However there is a clear distinction between potential uses of genetic science in containment and the release of a genetically modified organism into the environment.

A fundamental issue is the extent of the unknowns with genetic engineering – the things we don't know, and the things we don't even know we don't know. There is general insistence that any application of biocontrols or genetically engineered technologies must be undertaken with the utmost caution, after extensive testing and substantive engagement with the public, tangata whenua, and interested groups and sectors. A proactive, inclusive, strategic approach will be necessary to work carefully through the issues and reach understanding and consensus about what kinds of technologies will be acceptable to New Zealanders for use in our environment.

4.1.2 Biocontrol methods

In response to the various possible biocontrol methods currently being researched by New Zealand CRIs, as outlined in the information pamphlet provided to project participants (Appendix C), some strongly held views and clear priorities emerged as consistent patterns through this investigation. All the following patterns of response are subject to a range of fundamental criteria for acceptability of any new biocontrol technology intended for release into or use in the natural environment. These criteria include:

- Specificity to the target species, possums;
- Effectiveness;
- Humaneness;

- Rigorous long-term testing for any adverse effects on the environment or non-target species;
- Consistency with the principles of the Treaty of Waitangi and the Crown's fulfilment of its obligations to tangata whenua under the Treaty; and
- The technology being developed and brought to introduction through a process of full public information, consultation and involvement.

There was notable consistency in the reactions across the focus groups and others consulted. The responses to potential biocontrol methodologies were:

- The hormonal control method (sterilising animals via a toxin that affects hormonal processes) was favoured by many project participants specifically because it is the only method that would not involve genetic engineering;
- Interfering with lactation, or increasing the susceptibility of pouch young to disease (reducing possum numbers through infant mortality), were rejected by the large majority of project participants as inhumane;
- Immunocontraception was considered a generally acceptable option; and
- Immunosterilisation of adult animals was considered a higher-risk option than contraception.

The responses to potential delivery mechanisms were:

- Delivery of biocontrols by genetically modifying native plants was totally rejected by both tangata whenua and most non-Maori participants;
- Delivery of biocontrols via genetically modified parasites (eg. possum gutworms) was not considered unacceptable;
- Delivery of biocontrols via genetically modified viruses was considered an extremely high-risk option; and
- Delivery of biocontrols in bait form processed from genetically modified exotic plants (eg. carrots) was considered a lower risk, but lacking any obvious advantage over current control methods (eg. poisoning).

There is no implied significance in the ordering of these responses.

4.2 Policy Frameworks

There was a widespread perception amongst those consulted that there is a significant lack of strategic direction for possum management in general and possum biocontrols in particular. The inter-agency forum, the National Possum Control Agency (NPCA), has a role in co-ordinating operational aspects of New Zealand's possum control efforts, and the National Science Strategy Committee (NSSC) does provide integration of possum control research programmes. But the absence of a National Pest Management Strategy for possums is a critical deficiency.

There has also been to date no purposeful strategic framework developed within which New Zealand can learn more about genetic science and engage constructively with the researchers, decision-makers, policy agencies, tangata whenua and interested groups and sectors, to assess the potentials and risks of genetic science for our unique ecological, social, cultural and economic circumstances. However FRST is now fostering research into areas of possible genetic engineering impacts and social acceptability. The processes and findings of the Royal Commission of Inquiry will help both to generate debate and to determine appropriate means of advancing understanding on the many issues surrounding genetic engineering.

The ad hoc nature of New Zealand's efforts to address the complex, multi-faceted issues raised by biocontrols, especially when GE will be involved, is a significant constraint on the future development and possible societal acceptance of new technologies for dealing effectively with possums. A more co-ordinated approach is needed within which to develop policy, determine research directions and priorities, and ensure meaningful public consultation and participation in decision-making processes.

4.3 The Range of Values and Worldviews

This investigation has confirmed the wide contexts within which people think about and assess needs, benefits and risks, as they respond to a proposed new technology and its possible utilisation in the natural environment. There is a broad range of different objectives, purposes and priorities

underlying the approach of different groups and sectors to the practical business and the science of possum control. However the multiplicity of priorities and stakeholders need not rule out progress or the development of a constructive strategic approach. It will mean though that new models of dialogue and participation will be required.

It is obvious from this investigation that relying only on scientific frameworks is not going to be sufficient to address the many concerns and questions of New Zealanders about biocontrols and GE. A wide range of worldviews and value sets will need to be acknowledged, respected, understood and given space in the debates and the eventual decision-making processes.

Science is vitally important and must not be disregarded or under-estimated. Scientists and research policy-makers and investors must be encouraged in communication with the public, tangata whenua and interested groups and sectors, both to provide information about scientific research work, and to learn about the concerns and priorities of non-specialists. But science is only one factor in the equation, and the science community, official agencies and biotechnology industry must recognise that other disciplines and value frameworks also have validity and will be essential for satisfactory resolution of the issues.

The following set of principles is proposed as a starting point for developing frameworks for dialogue.

Box 10: Principles for the debate and decision-making processes

- ACCESSIBILITY for all interested groups and parties
- EQUALITY of opportunity to participate, with assistance and appropriate venues and formats for all groups and sectors to most effectively contribute their views, opinions and information
- INFORMATION from a wide range of sources as the basis for constructive discussion and robust decision-making
- TOLERANCE of and RESPECT for different viewpoints, values, priorities and ways of looking at the world
- Recognition of the TREATY OF WAITANGI and provision for fulfilment of the KAITIAKI responsibilities of tangata whenua
- Recognition of INTANGIBLE values as well as quantifiable information
- OPENNESS and TRANSPARENCY in regard to information and processes
- Engaging in DIALOGUE with others, to try to understand their viewpoints, values, priorities and ways of looking at the world, to consider others' ideas and proposed solutions, and to change one's own views and assessments accordingly
- RECOGNITION of those matters on which others are not able to change or to accept compromise
- Working within a SYSTEMS APPROACH which recognises the complexity, diversity and inter-relationships within ecological systems and within societal and human systems
- Accepting the PRECAUTIONARY PRINCIPLE – the principle that where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. This principle applies to the threats posed by possums, current control technologies (including market risks), and the risks of future technologies (including genetic engineering)
- Focussing on the GOALS – including:
    - reducing the impacts of possums;
    - protecting New Zealand's biological diversity, environmental sustainability and export markets; and
    - fulfilling Treaty of Waitangi obligations in regard to taonga of tangata whenua

  – as distinct from the science, technology, government systems, communications systems, and public participation systems which are the tools for achieving those goals

4.4 Public Participation

This investigation has explored the principle that the wider community wants to know more about what's going on in science and the development of new technologies, and to have more input into shaping the directions of this research.

There was wide insistence that the development of biocontrol technologies and any consideration of their possible use must be undertaken with full participation of the public, tangata whenua, and groups and sectors with an interest. It is only natural that people want to be informed, involved, and to have their views heeded in regard to a powerful new technology intended for application in the natural environment. In keeping with the principle of "consent of the governed", a democratic society has a responsibility to provide participatory frameworks for its citizens to consider and assess such powerful new developments, and a responsibility to abide by the outcomes of such processes.

Thus far New Zealand research institutions, research investors, and pest management agencies are only just beginning the necessary inclusive processes of discussion and societal engagement to fit biocontrols, especially those involving genetic engineering, into the social, ethical, economic, cultural, constitutional and Treaty contexts. These contexts will, as much as the quantification of potential benefits and risks by science, be the basis for societal acceptability of these technologies. This failure to engage with the wider contexts is a significant strategic vulnerability for the advancement of biocontrol science and for opportunities to improve our possum control "toolbox".

Strengthening trust in science, in environmental management systems, and in the decision-making processes must be a central part of citizen involvement. For people to have confidence in the technology and the processes by which it is assessed and (if acceptable) utilised, there must be far greater transparency and constructive dialogue than has been the case thus far in regard to genetic engineering and its possible future usefulness to New Zealand. Dialogue and communication initiatives must be two-way and open-ended. Any perceptions of coercion, "expert arrogance" or interest-group pressure will only further consolidate the current climate of distrust and polarisation. A set of suggested principles to develop constructive dialogue is offered in the box above.

In addition to the overarching principles, practical mechanisms need to be developed for:

- Systems for providing information to the public, tangata whenua and interested groups and sectors, and for actively encouraging the flow, exchange and building of information from a wide range of sources;
- Systems for challenging and debating information and the various associated issues, values and concerns;
- Systems for the wider general public to participate in the decision-making processes for any proposed use of these new technologies; and
- Systems for tangata whenua to participate, within the frameworks of tikanga, kawa and kaitiakitanga, and according to the articles and the principles of the Treaty of Waitangi, in the decision-making processes for any proposed use of these new technologies.

4.5 Knowledge and Information

This investigation has shown that there are enormous information needs for any meaningful assessment of the potentials and risks of biocontrols for possums. These have been outlined in the report above at 3.6, 3.11.6, 3.21 and 3.22.

The extent of what is yet unknown about biocontrols and genetically modified organisms is perhaps the most difficult and challenging aspect of this investigation. There are vast and fundamental gaps in our knowledge of those technologies, how they function, and what effects they might have on New Zealand's unique biodiversity, on non-target species or the broader environment, on metaphysical and ethical levels, and on the mauri, tapu and whakapapa inherent in physical taonga. There are equally critical gaps in our understanding of the attitudes and acceptability thresholds of New Zealanders, and of consumers in our overseas markets, for such technologies. It seems a precarious course for New Zealand's environmental, social and economic future to advance technologies with such potentially awesome powers and capacities, when so little is yet known about the methods themselves, their possible effects, and societal responses.

4.5.1 Information to the public

There is a wide demand for information on biocontrols and genetic science. However there are a range of factors in the nature, basis and perceived neutrality of information that are critical for its acceptance. Different groups and sectors in society have very different concepts of what kinds of information will be valid or relevant. In a highly interconnected world, where the most dominant information flows relate to product and service advertising, there is increasing public concern about the intent of "communication", its completeness and the trustworthiness of the source. Such questions were a pervasive sub-text through this investigation and contributed to the conclusions regarding community participation.

Information must be made as accessible as possible to the public in a range of different forms and venues. A proactive communication programme needs to provide New Zealanders with reliable information on:

- Possums, the extent of the damage they do and the risks they pose to our biodiversity and trade, their life cycle and physiological processes, the current "toolbox" of control methods, and the agencies and official systems under which control is managed;
- Biocontrol technologies, the science involved, the range of wider and global issues surrounding GE, and the testing systems and the work to ensure safety and specificity;
- The ethical issues at stake, and the various intangible values at the core of societal frameworks for appropriate human relationships with nature;
- The cultural and metaphysical values of tangata whenua, the rights guaranteed to tangata whenua in respect of natural places and taonga under the Treaty of Waitangi, and the implications of GE and biocontrol technologies for these values and rights;
- The intended benefits of biocontrols for possums, the need for such technologies and their intended advantages in comparison to the current control "toolbox", and the particular benefits biocontrols could provide to particular groups and sectors; and
- The range of risks for different groups and sectors, and various models for risk assessment and risk management.

4.5.2 Research priorities

The need for more information is reflected in the wide support for ongoing research. There is general agreement that scientific research must continue or be initiated in a number of related areas:

- Research into the science of biocontrols and possum physiology;
- Research into other opportunities and methods for possum control and integrated pest management;
- Research to establish the safety, effectiveness, controllability and humaneness of biocontrol technologies; and
- Research to establish robust, appropriate inter-disciplinary methodologies for the trialling and testing systems necessary to give confidence in safety, effectiveness, controllability and humaneness.

It was also generally agreed that research is urgently needed in the interface between biocontrol science and New Zealand society on a range of fronts:

- The criteria, values and priorities determining societal acceptability of new technologies in general and biocontrols and genetic engineering in particular, and the patterns within different groups and sectors of that acceptability;
- Information on the various interested groups and sectors, the official agencies involved, and their roles and objectives in pest management and scientific research;
- Frameworks for liability for any adverse or unintended effects of biocontrols;
- The ethical, moral and spiritual dimensions involved in using genetic engineering for pest control;
- The effects of such biocontrol technologies on the cultural, spiritual and metaphysical values of tangata whenua, and on taonga species and on resources and places of significance;
- The Treaty of Waitangi implications, especially in relation to the WAI 262 claim to the Waitangi Tribunal; and
- The economic implications of the various options for possum control in New Zealand (including 1080 and possible future GE biocontrols), including:
  - The costs of current management and of research;
  - The risks to the viability of our overseas trade; and
  - The economic risks possums pose to New Zealand.

5. RECOMMENDATIONS

These recommendations are made while recognising that Government, research and industry agencies and organisations are increasingly acknowledging that the future management of possums, possibly utilising genetic engineering, requires much greater involvement from New Zealanders. Many people from a wide range of groups and sectors have a stake in the "whats", "whys" and "hows" of controlling New Zealand's number one pest, particularly when it involves a field of science that will have far reaching consequences.

While there is recognition of the need for a better interface between science and society, the research into this need, and development of mechanisms to address it, are inadequate. These recommendations are aimed therefore at reinforcing some current initiatives and encouraging substantive actions on critical deficiencies. They are primarily to Ministers, in the belief that leadership in the management of this major strategic threat to New Zealand is a primary responsibility of Central Government. Possum management is a component of our biosecurity which ranks in importance for New Zealand with national security.

Recommendations to the Minister of Research, Science and Technology in association with the Ministers of Agriculture, Biosecurity, Conservation, Crown Research Institutes and Maori Affairs

1. To investigate the effectiveness of the uptake or application of publicly funded research on pests, such as the possum. To investigate, in the case of possum biocontrols, the specific adequacy of processes to translate research into product development programmes and, ultimately, technologies for approval and registration.

Explanatory Note

The ultimate utilisation of possum biocontrols will necessitate the development of products, and applications to ERMA for their use. The perception of many consulted during the study was that there is little coherence or strategic purposefulness in the processes for the research, community engagement, product development, and eventual application to ERMA. There appeared to be little clarity about who wants new controls, who will invest in all processes of development (including community engagement), and who would ultimately be an applicant to ERMA for any products. The lack of a National Strategy for possum management may also be a contributing factor to the lack of a clear process for developing new control technologies.

2. That there be a substantive increase in research into the interface between biocontrol technology, including genetic engineering, and New Zealand society. Areas requiring research include:
   - The ethical, moral and spiritual dimensions involved in using genetic engineering for pest control, including the values and beliefs of different groups and sectors within society and of tangata whenua;
   - The economic implications of the various options for possum control in New Zealand (including 1080 and possible future GE biocontrols), including:
     - The costs of current management and of research;
     - The risks to the viability of our overseas trade; and
     - The economic risks possums pose to New Zealand;
   - Frameworks for liability for any adverse or unintended effects of biocontrols; and
   - The Treaty of Waitangi implications, especially in relation to the WAI 262 claim to the Waitangi Tribunal.

Explanatory Note

While only qualitative, this investigation revealed that very little is yet known about public views, understanding and motivations in relation to the way possums are, or could be, managed. These, and the other aspects listed, require substantive investment to ensure community concerns and values become part of the risk/benefit/value frameworks within which future possum biocontrols are developed.

Recommendations to the Ministers of Agriculture and Conservation in association with the Ministers for the Environment, Biosecurity, Research, Science and Technology, and Maori Affairs, and all Regional Councils

3. In association with industry, Regional Councils, tangata whenua and other community partners, to expand education and communication programmes about possum impacts and risks, and the practicalities of possum control.

Explanatory Note

Despite programmes such as Project Crimson and ongoing publicity from the Animal Health Board and Department of Conservation about the threat possums pose, this study revealed limited understanding of the necessity, magnitude, costs and complexities of controlling possums. Unless there is ongoing recognition of, and consensus on, New Zealand's possum risks there will not, and cannot, be an informed debate about future control options.

4. To develop, fund and facilitate:
   - Mechanisms for ongoing fora to facilitate exchanges of information and views between community groups, tangata whenua, researchers, possum control agencies and Local and Central Government agencies.
   - An independent information provider to be a trusted source of information about possum control and new control technologies.

Explanatory Note

The future management of possums in New Zealand has to evolve with input from a wider range of voices than in the past. New Zealanders have a diverse range of knowledge, wisdom, views and beliefs that can make valuable contributions, but have in many cases not been given adequate opportunity in current research, government and industry dialogues. In addition, considerable effort must be invested into developing a trusted source of information, that can source, scrutinise and package information in ways that will effectively communicate the issues and the state of knowledge.

Glossary

Technical Terms

Biocontrol	using biological means (such as parasites, viruses or predators) to control a pest.
Biodiversity	the variety of all biological life (plants, animals, insects, fish, birds, invertebrates and micro-organisms), the genes they contain and the ecosystems and habitats in which they live.
Biotechnology	studying or manipulating one or more of the basic components of living things: tissues, cells, proteins, genes or DNA. It can includeidentification and characterisation of genes, genetic engineering, growing cells in a culture, or utilising cell components other than genes.
DNA	deoxyribonucleic acid, the molecule in chromosomes which controls inheritance through its functional units (genes). DNA functions as a repository of genetic information that is encoded in its base sequence.
Gene	the basic unit of heredity, a set of encoded instructions used by a cell to make a protein.
Genetic engineering	the process by which genes are added to or deleted from an organism to change the inherited characteristics of the organism.
Genetically modified organism	(GMO) an organism that has been modified by genetic engineering.
Transgenic	a plant or animal that has had genes transferred to it from another species.

Maori Definitions

atua	gods, the first supernatural beings
hapū	family or district groups, communities
hui	gatherings, discussions, meetings, usually on marae
iwi	tribal groups
kaitiaki	iwi, hapū or whanau group with the responsibilities of kaitiakitanga
kaitiakitanga	the responsibilities and kaupapa, passed down from the ancestors, for tangata whenua to take care of the places, natural resources and other taonga in their rohe, and the mauri of those places, resources and taonga
kaumātua	elders, decision-makers for the iwi or hapū
kaupapa	plan, strategy tactics, methods, fundamental principles
kawa	protocols, proper ways of doing things
kāwanatanga	government, the right of the Crown under the Treaty of Waitangi to govern and make laws

kereru	wood pigeon
kete	basket
kohanga reo	Maori language early education centres
korero	discussion, debate
kuia	respected older women in the hapū or whānau
kukupa	kereru, wood pigeon
kumara	sweet potato
kura kaupapa	Maori language schools
mana	respect, dignity, status, influence, power
marae	local community and its meeting-places and buildings
mātauranga	traditional knowledge
mate	sickness, disturbance, death
mauri	essential life force, the spiritual power and distinctiveness that enables each thing to exist as itself
te putaiao	the natural environment
rangatiratanga	rights of autonomous self-regulation, the authority of the iwi or hapū to make decisions and control resources
rohe	geographical territory of an iwi or hapū
rongōa	plants traditionally used for medicinal purposes
runanga	committee of senior decision-makers of an iwi or hapū
te taiao	the natural environment
Taitokerau	Northland region
tangata whenua	people of the land, Māori people
taonga	valued resources, assets, prized possessions both material and non-material
tapu	sacredness, spiritual power or protective force
tikanga	customary correct ways of doing things, traditions
wāhi tapu	special and sacred places
wananga	place of education and research, university
whakapapa	genealogy, ancestry, identity with place, hapū and iwi
whanau	family groups

Acronyms

1080	Sodium monofluoroacetate
ACRI	Association of Crown Research Institutes
ACVM Act	Agricultural Compounds and Veterinary Medicines Act 1997
AHB	Animal Health Board
ANZFA	Australia New Zealand Food Authority
BSE	Bovine spongiform encephalopathy ("mad cow disease")
Bt	*Bacillus thuringiensis*
CRC	Cooperative Research Centre
CRI	Crown Research Institute
DNA	Deoxyribonucleic acid
DOC	Department of Conservation
ECO	Environment and Conservation Organisations
ERMA	Environmental Risk Management Authority
ESR	Environmental Science and Research
FRST	Foundation for Research, Science and Technology
FSH	Follicle stimulating hormone
HSNO Act	Hazardous Substances and New Organisms Act 1996
IBAC	Independent Biotechnology Advisory Council
IFOAM	International Federation of Organic Agriculture Movements
IPM	Integrated pest management
MAF	Ministry of Agriculture and Forestry
MOH	Medical Officer of Health
NGO	Non Government Organisation
NPCA	National Possum Control Agency
NSSC	National Science Strategy Committee
OIE	Office International des Epizooties
PCE	Parliamentary Commissioner for the Environment
PGSF	Public Good Science Fund
PSRG	Physicians and Scientists for Responsible Genetics

RAGE	Revolt Against Genetic Engineering
RBAG	Rabbit Biological Advisory Group
RCD	Rabbit calicivirus disease
RHD	Rabbit haemorrhagic disease
RSPCA	Royal Society for the Prevention of Cruelty to Animals
SAFE	Save Animals from Exploitation
SIAC	Science and Innovation Advisory Council
Tb	(Bovine) tuberculosis
tPA	Tissue plasminogen activator
VPC Regs	Vertebrate Pest Control Regulations

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Appendix A

Public and interest group perceptions of possum fertility controls: a summary of the focus groups

Roger Wilkinson, Gerard Fitzgerald, and David Chittenden

A report by Landcare Research, New Zealand, as part of a wider investigation by the Office of the Parliamentary Commissioner for the Environment

Research context

Dealing with pest animals is not simply a technical issue; it is also a public issue. Many members of the public want a say in how New Zealand makes decisions about how to control pests, what methods are used for control, and even whether some are pests at all. The public's perception of pests and pest control is thus an important factor in the decision-making process. The Australian brushtail possum (*Trichosurus vulpecula*) was originally introduced to New Zealand in 1837 to establish a fur industry, and is now New Zealand's major pest mammal. The next potential major advance in control of the possum is likely to involve fertility control. Developing such a control may involve genetic engineering (GE). And GE is itself a very topical and emotionally charged public issue at present.

A number of recent research studies have been directly relevant to public perceptions of the biological control of possums in New Zealand. Sheppard & Urquhart (1991) asked questions about possums as part of their survey on public attitudes to various pests. Fitzgerald, Saunders & Wilkinson (1994) conducted a large-scale study with qualitative and quantitative components, focussing on both possum and rabbit control, involving examination of the attitudes of the public and sector groups. The work was summarised in Fitzgerald, Saunders & Wilkinson (1996). Since then, Wilkinson & Fitzgerald (1998) have conducted further, similarly structured, qualitative and quantitative research on public perceptions of rabbits and the then-proposed release of rabbit haemorrhagic disease (RHD, previously called rabbit calicivirus disease, or RCD). New Zealanders have similar attitudes to rabbits and their control as they have to possums, although possums are native to Australia and protected there.

None of these previous studies have assessed in detail how people perceive fertility control of possums. Nor have they evaluated perceptions of particular fertility control mechanisms. The Parliamentary Commissioner for the Environment (PCE), in association with Landcare Research and AgResearch, undertook an investigation to determine the range of views of New Zealanders about the possible use of fertility-based biocontrols for possums and, in particular, genetically engineered control methods. As part of that investigation, Landcare Research conducted qualitative research in late 1999 into public and interest groups' perceptions of fertility control of possums, including genetically engineered controls. The following report is on that research.

At the time of the research there was a lot of public attention on genetic engineering, especially genetically modified foods. A general election was being held and there was a lot of positioning about genetic engineering, particularly by aspiring politicians. The intense public discussion and media coverage of the issues also meant people were very aware of some of the issues and had an opinion. In short, concerns about genetic engineering were considerably amplified at the time of the study.

Methodology

As with any research on public perceptions of new or contentious technology, evaluating the public acceptability of fertility-based biological control technologies for possums requires assessment of two components: the range of views and how widely they are held. Identifying the range of views

is a qualitative task; determining how widely the views are held requires a quantitative survey and is best done after the range of views has been identified. The study reported here was designed to assess the range of views by using a series of discussions with focus groups.

Focus groups are, as Morgan notes in his 1988 text, "basically group interviews", where

> the reliance is on interaction within the group, based on topics that are supplied by the researcher, who typically takes the role of a moderator. The fundamental data that focus groups produce are transcripts of the group discussions (p. 9).

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 (Merton & Kendall 1946), and developed by Merton and Paul Lazarsfeld in subsequent decades.

Interactions between focus group participants are encouraged, to stimulate discussion and thereby elicit beliefs and values in depth. Follow-up questions may be necessary to deepen the discussion. The hallmark of focus groups, according to Morgan, "is the explicit use of the group interaction to produce data and insights that would be less accessible without the interaction found in a group". So, while a series of thematic questions may be put to the group, discussion, like everyday conversation or argument, is frequently non-linear. The moderator's role is primarily to ensure the set topics or themes are covered without stifling the creativity of free exchange between the participants. As such, focus groups are "better suited to topics of attitudes and cognitions" (Morgan 1988, p. 12). In comparison, participant observation (another widely used and accepted qualitative method) "is superior for studies of roles and organizations" (Morgan 1988, p. 17).

This study was intended to be essentially exploratory, canvassing the range of perceived issues and attitudes on the controlling of possum fertility, through the use of genetic manipulation and other techniques, in order to deal with the possum pest problem in New Zealand. Use of the focus group technique therefore seemed appropriate for the research.

Focus groups were also considered by the researchers to have the following key advantages for this study:

- ability to access a wide range of viewpoints — particularly when a range of different interests (and therefore perspectives) were covered — generating a comprehensive body of data;
- the possibility of consistent format — as far as is possible in focus groups — through the use of a standard set of questions to be put to each group and the provision of a standard set of background information;
- cost- and time-effectiveness — being relatively easy to organise and conduct given the resources and time available;
- the researchers' previous experience of organising, conducting, and analysing focus groups on closely related topics.

The analysis of the focus group discussions was undertaken using a procedure developed by the researchers in previous focus group studies, and based on suggestions from Krueger (1990). The basic steps involved: listening to the audio tapes of each focus group in conjunction with the written notes; preparing annotated discussion flow diagrams of each focus group while making reference to the audio recording; 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.

The researchers' challenge was to ensure the widest possible range of views was canvassed, within the time and budget constraints of the project. This means that the researchers cannot claim to describe the relative balance of the different viewpoints, but can claim to describe the range of views that were expressed in the focus groups. Any description in this report of the extent to which views were held, or the strength with which they were held, is meant in a qualitative sense only. As mentioned already, to describe the relative balance of the different viewpoints requires a quantitative survey, the design of which would be informed by the findings of the present research.

In consultation with the PCE and the reference group established by the PCE to advise on the wider investigation, it was decided to hold a series of nine focus groups and one hui. The choice of

groups and the kinds of individuals in the groups was guided by the results of two series of focus groups and surveys on similar issues (Fitzgerald *et al.* 1996; Wilkinson & Fitzgerald 1998). Some groups consisted of members of the public; others involved people with a special interest. In previous research, in 1994 and 1996, differences were observed between the responses of men and women, and between urban and rural people. In the present research, separate focus groups were therefore held with men and women in Auckland, and a group in a provincial area (Levin). The Office of the PCE recruited participants in the three groups by approaching school parents' associations. The schools in Auckland were selected by the Office of the PCE, based on data on the demographic characteristics of their neighbourhoods (based on Census area units) provided by the researchers, as recorded in the 1996 New Zealand Census of Population and Dwellings. Neighbourhoods chosen were close to national mean levels of age, ethnic composition, income, and education.

The special-interest groups identified by the researchers were: scientists and health (including public health) professionals; people with an ethical interest and concern about the treatment of animals; industry practitioners (farmers, foresters, people involved in pest control, people in the biotechnology industry); opponents of genetic engineering; and people with environmental interests. To gain an iwi perspective, a hui with people from a South Island iwi was also held. All participants in these groups were recruited by the Office of the PCE, following suggestions provided by the researchers on the range of participants required. The Office of the PCE also scheduled all the focus-group meetings.

The focus groups, their locations and meeting dates, and the name by which they are referred to in the rest of this report, were:

- Public women, Te Atatu, Auckland, 18 November 1999 (Women, or W);
- Public men, Birkdale, Auckland, 17 November 1999 (Men, or M);
- Mixed provincial public, Levin, 26 October and 2 November 1999 (Provincial, or P);
- Scientists and health professionals, Wellington, 23 November 1999 (Scientists, or S);
- People with ethical interests, Palmerston North, 24 November 1999 (Ethics, or E);
- Industry practitioners, Christchurch, 11 November 1999 (Industry, or N);
- Opponents of genetic engineering, Wellington, 25 November 1999 (Opponents, or O);
- People with conservation or environmental interests, Auckland, 18 November 1999 (Environmentalists, or C);
- South Island iwi group, Christchurch, 9 November 1999 (Iwi, or I).

The Office of the PCE produced a comprehensive information pamphlet, prepared in consultation with biologists and the reference group established by the PCE, to provide the focus-group participants with information on the various forms of fertility control for possums currently being researched (See Appendix C of PCE report). The pamphlet described the methods and explained some common concerns people had expressed previously about these. This pamphlet was circulated to participants before the meetings. A more detailed technical paper was also made available to participants at each meeting (See Appendix D of PCE report).

The first focus group (Provincial) was designed to pilot test the questions and prompts. The researchers also tested a new approach to focus groups of holding two separate meetings with the group, a week apart. The first meeting was designed to elicit participants' perceptions without their having been exposed to the PCE information pamphlet. They were given the pamphlet at the end of the first meeting. The group was reconvened a week later to discuss the issues again, having read the information pamphlet, and to provide participants with the opportunity to ask technical questions of a possum-control research scientist. Little change in participants' perceptions between the two meetings was observed, so the double meeting approach was discontinued. However, the second meeting confirmed the utility of having a technical expert available to answer questions.

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. As noted previously, because participants were encouraged to engage each other on matters of attitudes and values, discussion of the set topics frequently moved in a non-linear fashion, with the moderator ensuring each of the topics was covered in the time available. All group discussions were audio taped for later analysis. Focus-group discussions generally lasted from 90 to 120 minutes. Each focus group was typically conducted by two researchers (one acting as moderator,

one as recorder). Officers of the PCE attended to observe and to provide a briefing on the wider PCE investigation and the information in the pamphlet. One of the PCE officers also assisted with moderation of two groups. Each of the single-session focus groups was attended by a possum-control research scientist, to answer any technical questions raised by the group.

Verbatim comments from the participants are indicated in this report by italics and are indented from the margins. Words that appear in italics within the general text are taken from the annotated discussion flow diagrams prepared while listening to the recordings of the focus groups, and are faithful to the language used by the participants. The hierarchical topic-based listing of all points made was used as the basis for the following summary of the focus-group discussions, including the illustrative quotations. The context of particular quotations was checked against the discussion flow diagrams.

Findings

Participants described a wide variety of experiences of possums. These ranged from none (M) and *didn't realise they were a big problem* (W), through *had a pet possum*, *keep me awake at night*, and *ran them over* (M), through to people in several groups who had shot, trapped, or poisoned them (P, M, W, O).

The "Possum Problem"

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 researchers considered that this was necessary before people could properly discuss the issues surrounding fertility controls, and most groups spent longer discussing this than had been envisaged. 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). These had been mentioned in the PCE information pamphlet, but not at this level of detail. 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).

The environmental damage caused by possums was seen as clearly observable, but strong scientific evidence of the extent of the damage they caused was seen to be lacking: *what damage do they really do?* (P), *hard to nail down the magnitude and extent of the problem* (S). Also, the decline in certain plant, insect, and bird species was seen as possibly not due to possums alone; the need to put possums in context was mentioned by several groups. Possums were *just another introduced species* (E), along with deer, stoats, weasels, and invasive weeds, and therefore the possum problem needed to be prioritised against other conservation problems as part of an *integrated conservation effort* (E). New Zealand needed to decide on the overall priorities and goals, and possums might be, say, *number 19 on the list* (C). Most groups, however, made some mention of possums as an economic resource, especially for a fur industry, but noted that people would be tempted to not kill all of the possums, but leave a few behind.

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 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). The widespread presence of Tb in New Zealand was described as a *potential barrier to trade, with significant economic implications* (S); however, a vaccine to immunise cattle against Tb, if developed, would render Tb control a much less persuasive argument for possum control than it was at present. The trade issue was complex, and the presence of Tb in animals such as deer and possums, even if cattle were immunised against it, might mean that *we could not claim that New Zealand was Tb-free* (S).

Other goals of possum control mentioned included protecting public health, water conservation, and protecting water quality (e.g. giardia in urban water supplies). Even within the goal of environmental protection, several subsidiary goals were mentioned: *restoring the "dawn chorus"*, *seeing lots of pretty trees*, *encouraging birds*, *protecting threatened species*, and *creating a pristine-looking environment for overseas tourists* (C). The Industry group suggested that the environmental and animal health (Tb) goals of possum control did not sit well together, because the control effort was greatest in areas where Tb was an issue, and these were not necessarily the areas requiring biodiversity protection. *To the public, biodiversity is the bigger issue* (N).

In several groups the issue of whether possums should be eradicated, controlled, or lived with, was raised. In most groups, at least one participant said that possums should be eradicated: *get rid of them totally, aim for zero numbers* (W); *we don't even want to keep one possum* (M). However, some groups expressed the view that total eradication was not feasible (*we need to manage the problem . . . but we shouldn't think that we can solve it* — C). This extended into a discussion about whether it might be desirable — or even necessary — to simply live with the possums: *they're all animals, they're here, they have a right to stay, we have to live with them* (E); *there must be creative ways of dealing with them* (M). In any case, a *co-ordinated effort* was required, involving *everyone working together* (P).

Although there was general agreement that possums needed control, or even eradication, some philosophical concerns about possum management were raised. The most widely expressed of these was the need for possum control to be seen and presented positively rather than negatively. *The issue is not just pest control* (C). Killing possums merely to perpetuate a possum-killing industry was unacceptable: some participants mentioned possum-killing gangs with such a mentality; others spoke of a *mindset about eradication* (C), a mindset evident among participants in several groups: *get rid of the buggers, send them back to Australia* (I). One participant in the Environmentalists group said that killing possums could be justified only if there was a clear end result:

> *I think we have to look at . . . the area of where do we want to go, 'cause I see, I see it developing, a killing culture in New Zealand, from now until infinity, to control the pest without an end result, and I think that's wrong, very wrong. If there's an end result, to manage our biodiversity, to whatever direction we want to go in, fair enough, therefore killing can be justified, whatever technique you use. But if there's no end result there, that's going to do this killing to infinity, that is very very wrong, and I think that will be resisted by many New Zealanders, especially in the animal rights area and from the urbanisation of nature that's occurring.*

A participant in another group went further, describing the need for a direct relationship between killing possums and saving particular native species, such as kereru: *you need some more compensation for the killing bit than just this abstract notion that one day the indigenous forest will recover* (S). A need to *turn the problem around on its head* was described, to *create the habitat we want*; this might involve goals such as *bring bellbirds back to urban areas, kokako* (C).

The argument that, in the relationship between humans and nature, humans are *playing God* (C) by killing possums was mentioned in the Environmentalists and Iwi groups, and rebutted strongly: *we played God when we introduced the possums . . . that gives us a duty to carry on playing God to take responsibility for our initial folly* (C). Because possums were introduced to New Zealand, and therefore are not natural, *you can't reject artificial means of controlling them* (I).

Current control methods

There was a general perception in the focus groups that there were problems with current possum control methods, either because they had limited effect given the scale of the problem, or the costs were unacceptable: *we're not really winning the war* (M); *we'll never eradicate any of our pests using our current methods* (C). These points had also been raised in the PCE information pamphlet. Quite apart from the issue of their general effectiveness, there were specific concerns about current methods.

1080

The most widely used poison at present, 1080 (sodium monofluoroacetate) was seen by the participants in several focus groups (mainly the public ones) as very dangerous. Concerns about its getting into the water supply, leaving residues in the environment, and killing dogs and other animals were mentioned. Someone in the Ethics group observed that

> *we've known for a long time how unpleasant 1080 is. We don't care about what 1080 does to possums, we care about what 1080 does to other aspects of the environment*.

The widespread 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

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, as noted in the PCE information pamphlet, *traps catch other animals* (W). Shooting and trapping were associated in earlier discussions about possums in general 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).

The groups recognised that, despite the inadequacies of current possum control methods, no new methods were likely to be developed quickly. There was some recognition that 1080 (the *least worst* control option — M) still needed to be used. *We still need current tools* (N). The need for new possum-control tools was expressed by some groups. In the Provincial group, this preference was couched in terms of opposition to 1080: *no one wants 1080, but unless we do something else we will have to keep using 1080*. The Opponents group expressed a preference for more benign and non-GE methods of controlling possum numbers, such as biodynamics, and suggested that resources should be put into researching these methods: *how much research is going into alternative things, other than GE?* This group also wondered whether, *if possums cause $60m damage to agriculture, what would happen if we spent $60m on control?*

Biocontrol

When asked how they felt about a biological control for possums, participants discussed various organisms that could be used. 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 (both having been mentioned in the PCE information pamphlet). 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).

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).

Biocontrol was commonly perceived as not providing the whole answer for possum control. This was voiced in various forums. It would not get rid of all the possums: *no method will kill them all* (P); *If the population is already limited by some kind of pressure, then you have to kill somehow faster than they can replace, or they will breed up again. If you're only knocking out certain possums, you're allowing the others to thrive, you don't want them to breed up again* (E). It was seen as being slow to take effect: *biocontrols are slow, not an overnight success* (M). Several groups felt it would not replace other methods: *it won't do away with chemicals, there will always be some need for them* (S); *need to combine all control methods in an integrated approach* (I); *How far away is biocontrol? We need something fast-track* (I). Participants expressed concerns about how well RCD was working: *rabbits become immune* [to RCD] (P), RCD *didn't keep working. What's the guarantee* [a biocontrol] *for possums would?* (W). *If farmers had realised that, by introducing RCD, they would produce a strain of RCD-resistant rabbits, they might not have rushed in and brought it into the country* (C). The logical extension of these concerns is *will possums become immune?* (P).

Ecological concerns about biocontrols 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 biocontrol 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).

The Environmentalists group wondered whether, because possums were introduced from Australia, there were any parasites and viruses of possums in Australia that could be introduced to New Zealand. This idea was treated with concern in the Women's group: *Who's to say a parasite introduced from Australia won't affect native birds? Just because it doesn't affect birds in Australia — they don't have kiwis running around in Australia.* The Women's group then challenged the scientist present: *are you able to guarantee it? You're not, are you? You can't guarantee things won't alter or change*. The challenge was specific to this particular issue, but may also be indicative of a general concern.

Several groups expressed concern about the impact a biocontrol 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 biocontrol 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).

Any proposed biocontrol needed to be researched thoroughly, according to the participants. *It will take years to get the biology correct* (S). There were, however, perceived difficulties in researching a proposed biocontrol introduction: *Tests on other species are done in a very controlled situation. Put it out into the environment and there's a whole lot of other factors* (W). The research was still worth doing: biocontrols might be acceptable *if the research is done right and they are proven* (M).

One perceived advantage of biocontrol was that it was efficient: *Biocontrol works 24 hours a day, 7 days a week. It gets into areas people can't get to. It's doing the work for you, you don't have to find every possum* (M).

Fertility control

Following on from biocontrol issues generally, discussion then moved to consideration of the different fertility controls currently being researched (as outlined in the PCE information pamphlet). The two most extensively discussed criteria for acceptability of a fertility control were whether it was specific to possums and whether it was humane. The discussions on these issues are presented below. Participants in public groups responded with their own personal concerns; participants in interest groups often expressed both their own personal concerns and those they thought were important to the public.

In the analysis of the issues raised in the focus-group discussions, the researchers often found that expressions of concern about the risks of biocontrols generally, the risks of fertility controls, and the risks of genetic engineering overlapped in the discussions. The groups did not clearly distinguish between the different technologies in terms of risk. As a participant in the Men's group argued, *it's splitting hairs to say fertility control and genetic engineering are not necessarily the same*. Given the information on the various possible forms of fertility control being researched in New Zealand that was provided in the PCE information pamphlet, this lack of distinction between the perceived risks of the technologies is understandable. As noted in the pamphlet, genetic modification or engineering is involved in all but one of the fertility controls being researched. It is understandable, given the level of public interest in GE at the time of the study that the participants might focus on the GE aspects of the fertility control technologies outlined. In this report, the discussion of these undifferentiated risks is presented in the section on genetic engineering, below.

Specificity

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". One group, having expressed a need that any fertility control be safe, and being asked by the researchers what they meant by "safe", exclaimed *it's obvious!* (P). People's greatest fear, whether for biocontrols 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. It was expressed in both the public groups and the interest groups as a personal concern, and in the interest groups as a possible concern of the public: *this is the thing that people worry about greatly with biocontrol* (E) The Industry group went even further, saying that one component of the safety of a fertility control was *no negative perceptions from the public*.

Concerns about specificity were expressed in various ways: as an unarticulated fear — *it's all a "what if?"* (W); as a generalised concern — *only affects possums* (P); *doesn't mutate* (P); *can we be sure only possums will be affected?* (E); in more detail — *lack of probability that it will change and become a danger to something else* (E); *not presenting danger to other species, including plants, humans, other animals* (E); and in even greater detail — *we have to think about whether it will affect other, similar species that may have similar habits and habitat* (M); *you would want it so specific you could control it* (M); *if we could identify methods that were absolutely unique to marsupials and target those (and I believe there are some), knowing that the only marsupial in New Zealand of any note was the possum, we could have something specific to possums* (E).

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). This expressed need for certainty is common when contentious and potentially risky new technologies are being discussed: this will be covered in a later section on genetic engineering.

A range of other specificity concerns were also mentioned: *what if some other animal eats the rotting possum?* (M); *does anything eat possum faeces?* (W); *bees can take the pollen off other crops* (M); *RCD shows the problem with using a vector like a flea to spread it, what's to stop the vector spreading to other species?* (N). An Ethics group participant noted that, even if a fertility control released in New Zealand was specific to possums, New Zealand's trade with Australia might still be affected.

Humaneness

Another perceived determinant of the acceptability of a fertility control was that it was humane. As with specificity, humaneness was mentioned as both a personal concern (*prefer that the animals die humanely* — C) and, by some participants in the interest groups, as a perceived public concern (*the more humane a control is, the better it will be accepted* — E). Many comments about humaneness were made about particular fertility control methods, especially interfering with lactation and increasing the susceptibility of young possums to disease, but some were general. Humaneness was also raised in earlier discussions of trapping and poisoning. 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). Issues of humaneness generally emerged during consideration of interference with lactation and remained "on the table" during subsequent discussion.

The Ethics group, in particular, described international implications of New Zealand's possum management decisions, and this included humaneness considerations:

> *There is a very strong perception internationally of the importance of animal welfare, and if we are seen to be killing off millions of possums a year with what are roundly regarded as inhumane methods and taking no care to try and find out more humane methods and evaluating those that are available and still using the worst ones when you could use better ones, this will jeopardise our international image in all sorts of ways*.

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). A participant in the Ethics group summed up the trade-off: *I don't think the animal welfare argument will be a priority. The extent to which it will be made a priority depends on how pressing the problem is. It will become a more pressing priority, the more welfare-friendly methods become available, and less of a priority the more pressing the possum problem is seen to be in a particular area. Any method will be acceptable if possums are seen to be in plague proportions*.

Several other comments were made about the relativity of humaneness considerations. The women's group had a comprehensive discussion on this point, including the following comments: *it's only when you think about it that humaneness becomes an issue — we don't worry about spraying flies*; and *humane considerations are less important, so long as I don't have to see it*.

Acceptability of particular fertility control methods

After being given a verbal briefing of the various fertility control options being considered (using information in the PCE information pamphlet), participants expressed their reactions. A member of the Scientists group commented *I hadn't realised there were so many methods*. Several generally positive comments were made: *possums do so much damage we need to investigate as many options as possible* (C); *you wouldn't develop only one, you'd develop them all to find out the pros and cons* (S); *any of these methods are worthwhile, there would be a hierarchy among them* (M).

Hormonal Control

The hormonal control that did not involve 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*. No comments were made about its likely humaneness. The PCE information pamphlet noted that this method might involve the use of a toxin or poison; however, this aspect of hormonal interference was not raised by the groups.

Interfering with Milk Production

Reactions to the idea of a fertility control that interfered with milk production were polarised. On one hand, the image of baby possums starving was seen as distasteful, particularly for women and children: *women and girls I spoke to didn't like it* (P); *why should a baby be starved?* (W); *lingering starvation, death* (W); *if children hear that baby possums are starving, you will get into emotive issues* (P). In this respect, it was seen by the Scientists group as no better than 1080: *is it an improvement to substitute one distasteful means of killing possums for another distasteful one?* It was also seen as ethically questionable: *you're deliberately starving babies, rather than the whole population*; *no food for the joey seems a drastic way of starving the population*; *killing life, rather than preventing life*; *like clubbing baby seals* (S); *stopping milk supply to joey more wrong, because more cruel* (C); *may be a problem for the mother, who finds her pouch young dead* (E). Again, an interest group (in this case, Scientists) claimed that the *public would not accept the starving of baby possums*.

On the other hand, concerns about interfering with milk production were responded to in several groups. Some responses were brief: *get real, you have to kill them somehow* and *no one will see it* (P). Others, like this explanation from an Ethics group participant, were more expansive:

> *when they're born they're more or less a spinal cord, a mouth, and a gut, they have no brain and brain structures that are necessary for consciousness, and an unconscious animal can't suffer. . . So, in fact, my perception of it is that if it is early pouch young that are caught by the dramatic reduction in milk production, that is not going to be a major welfare consequence to the pouch young. . . In terms of the mature ones it is a bit hard to reason, but I'm reasonably convinced that dying of starvation over 4 to 6 days, which is the maximum it would be likely to take in mature pouch young that were dependent on milk, and milk supply was cut off, would probably be preferable to a longer, or a death of equal duration but more pain, due to a poison.*

One participant in the Scientists group said it *might be more specific than some other methods*, which *might make it more acceptable to the public*.

Increasing Susceptibility to Disease

A fertility control method that caused increased susceptibility to disease was seen as distasteful by the Women's group. *Why should a baby die a painful death from some disease? If your daughter or son has a sore throat it's a major thing. Why should a baby possum suffer through something like that, just because it's a baby?* Further, *they can't guarantee it is going to work on all of them* (W).

Sterilisation

Sterilisation was more 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*. Again, 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 it 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 animal welfare implications of the various methods were summarised in an academic sense by a member of the Ethics group:

> *It seems to me that some of these methods are going to be uncomfortable for the possums and some of them are not, the one which leaves them unable to nourish the young means that the young die of starvation, the one that leaves the young vulnerable to diseases because they have no immunity means that they die of a disease, the one that renders them sterile doesn't appear to have anything like the same invasive effect, and is probably therefore preferable from a welfare point of view.*

And, in a lay sense, by a member of the Women's group:

> *why should the baby be starved, or have no* [immunity]*, or die of a painful death of some disease, there's no need for it, you know. Stopping them from producing babies would be better than killing the babies, I mean, no matter how much of a problem they are, there's still no need to hurt them.*

Genetic Engineering

General Reactions

Initial reactions by those in the public groups to the idea of using genetic engineering to create a fertility control for possums involved a general unease that some participants found difficult to articulate: *it makes sense intellectually, but emotionally it's a bit obscene* (M); *it sounds great, but you don't know. What if something goes wrong? What if it mutates?* (W); *if we could do biocontrol without genetic engineering, I'd be a lot happier* (P). The Industry group, particularly, was conscious of this public unease about genetic engineering, and several statements to this effect were made in that group: *getting public acceptance of biocontrol will be difficult; getting acceptance of genetic engineering will be a quantum leap*, and *don't underestimate public fears about genetic engineering. If people see a biocontrol contains genetic engineering they will zero in on the GE part and reject it*, and *biocontrols have been around for years, but I don't think the public are ready for genetically engineered solutions*.

A variety of ethical concerns about genetic engineering were raised. Some participants were concerned that genetic engineering was "not natural": *we're pissing around with nature too much* (P); *crossing species boundaries does not happen in nature* (P); *altering the natural way of things, making something that wasn't there to begin with* (P); *changing nature, it's just not the way it should be* (W). Also, *ownership of nature, patenting life forms is wrong. There is a revolt coming from the people saying you cannot own nature* (C). Some people were opposed to genetic engineering for spiritual reasons, concerned about *messing with things we do not understand, maybe even things we do not know exist* (O). The Ethics group discussed animal ethics. *The dignity of what an animal is and has evolved into is seen by some people to be of major moral consequence*, said one participant. This was countered by an other: *in a lot of people's minds, pest species are somehow excluded from this, they're some kind of "outlaws". And introduced species are* [also excluded] *on other grounds, and possums are both*. Other ethical concerns mentioned by participants included potentially unique Maori perspectives on GE, in relation to whakapapa, kaitiakitanga, and changes in customary relationships with native flora and fauna.

Some alternative approaches to genetic engineering were offered. These included organics (M, C) and biodynamic methods (O). Comments about organics included: *one of the major futures for New Zealand is in organics. If we do something that will cover 95% of New Zealand's land mass, it will have to fit in with that . . . We do have a problem, something has to be done, but it has to be done in a way that enhances our future, rather than rushing into it* (M). New Zealand's "clean, green" image was also mentioned: to one of the Industry group, loss of the "clean, green" image (for whatever reason, not necessarily through genetic engineering) *would have a detrimental effect on our business*. Also, *how does New Zealand want to promote itself internationally? We can't promote ourselves as clean and green if we have biological warfare with our native plants* (O).

Uses and Degrees of Genetic Engineering

With further discussion in the focus groups, participants were able to articulate their concerns about genetic engineering more clearly. People recognised that there were a range of uses of genetic engineering, and that the acceptability of the various uses was different. *People accept GE for medicines, but GE food has much lower acceptability. Biocontrol is somewhere in between* (S); *GE for possum control is more acceptable than GE for food* (P); *I wouldn't give GE a blanket "no", I would look at everything case by case* (I); *I wouldn't want to stop GE for curing diseases* (I).

Even members of the Opponents group said they were not against all genetic engineering: *I'm all for a ban on GE food, but pro using it in human health research*; *Some people tout GE as the only hope to cure certain diseases. There'd be an uprising if we wanted it banned*. Group members described the organisation to which several of them belonged, RAGE (Revolt Against Genetic Engineering), as being *specifically against GE food*. One of the participants in that group worked in a laboratory that used genetic engineering for medical research, and the rest of the group seemed to accept this: genetic engineering was described as *a basic tool of molecular biology*, *at the forefront of human health research*. Genetics was *a great resource of knowledge*, and *to get that understanding you have to do GE in the lab*. And of biocontrol, one of them said: *this is an unusual application of GE, not food, not medicine, it's altruistic*. The group also said, however, that some people did want a total ban on all genetic engineering.

Some participants were wary of supporting genetic engineering in possum biocontrol applications, seeing it as a Trojan horse or the thin end of the wedge: *GE for possum control is about getting the foot in the door for GE for food, to reassure us it's safe* (P); *When you allow GE for possum control, that says to the New Zealand public, "look at this wonderful tool for controlling possums", they think perhaps it's not so bad if we have it in our food, or crops grown in the environment* (O).

Not all participants were confident about which uses of genetic engineering they supported: *Some GE will have wonderful benefits to mankind. Which are going to be the good ones and which are going to be the bad ones? We don't know* (P).

Different degrees of genetic engineering were recognised. One point for discrimination by participants involved the species of genes that were manipulated. Manipulating genes of the same species, or closely related species, was seen as more acceptable than manipulating genes from more taxonomically distant species (transgenics): *Only manipulate possum genes, don't introduce genes from any other animal, then it can't mutate* (P); *if something that made them sterile could stop other animals from breeding, I'd rather work with the possums' own DNA* (W); *alter the possum's own DNA so it doesn't breed, rather than use a virus* (P); *in this example, possum genes are being used against possums* (E); *I'm not keen on introducing frog genes, it's going beyond what is natural* (P).

The other issue about degrees of genetic engineering was whether it represented a completely different way of manipulating organisms from those used in the past, or simply an evolution from breeding techniques used in the past. This was discussed mainly in the Ethics group, which contained some senior scientists who were involved with genetic engineering research. Several examples were given, including one of a vaccine developed for tuberculosis control in the 1920s, that involved *a genetically modified organism by any modern definition* and, *although they did all the genetic modification things, but they used the "soup" method, rather than the "probe" approach*, *everyone accepted that this was a "good thing"* (E). Not all the participants in the group were convinced by this argument, however, with one suggesting that if genetic engineering

involved modifications that could not have been achieved by selective breeding over a long term, and involved more than simply speeding up the breeding process, then it would be seen by the public as quite different from past techniques. One member of the Ethics group observed that *genetic engineering seems powerful to us, but in comparison with the powers of God it is piffling*. The Opponents group recognised that a product of a genetically engineered organism may or may not contain genetically modified material itself. *We know that something that comes from a GE source doesn't necessarily contain any of the manipulation you have done. If you could prove that, then people would accept it more, because you are taking precautions. If you could not prove it had no GE material, I would not want you to risk it*.

Risk and Safety

A major concern about genetic engineering was its safety. As with fertility control generally, "safety" meant mainly specificity of the control and any vector to possums: *can you guarantee it won't get into any other animal?* (P); *People in favour of it are trying to promote the delusion that it is host-specific. I don't think we have the technology to do that. Viruses and bacteria change rapidly and mutate and exchange DNA* (O).

Some concerns about the safety of genetic engineering went beyond this to all kinds of unforeseen effects. Such effects could be on humans: *I'm totally opposed to GE if you can't prove to me that in 20 years' time, without reasonable doubt, that it won't impact on the human race, and I doubt whether you would be able to do that* (M). They could be on possums: *You're attempting to control something and you don't know what impact it will have on the possum, down the track, when you did it for 5 or 10 years. Nature will do something to counteract what you are doing* (M). It could be an effect that no one can imagine now. To the public, this meant *things done in the lab have huge side effects* (P) and *if you have made a Frankenstein protein you don't know where it's going to end up* (P). To the interest groups it was *making a change for one reason can result in effects in another area* (C), *radically altering one bit of something can have effects beyond what you can see* (S) and *inability to measure something does not mean it's not there* (S). Various methods for minimising unforeseen consequences were suggested, and these are discussed below.

Participants couched their concerns about the safety of genetic engineering mainly in terms of risk. The main issue was whether a small risk of a genetically engineered fertility control for possums having an unforeseen effect could be traded off against other risks, or whether an absolute guarantee of no risk was required.

Several groups discussed trade-offs. *There's a point where you say, which is the greatest risk, losing a percentage of our forests every year or losing what we don't know, future generations* (O). *You've got this problem already. Do we risk a problem that may or may not happen, to get rid of that problem?* (W). *Is the "cure" worse than the "disease"?* (S). Two members of the Men's group had a discussion: A — *I'd be prepared to put up with some risk (e.g. if the parasite did live on and link into something else), with the benefit that it was going to wipe out the possum population.* B — *But I'm not prepared to take that risk, I'd like a bit more certainty. I'm concerned for my children and their children.* A — *But life's full of risks. Every time your wife has a baby, you hope like hell it will have two arms and two legs.* B — *No! None of us know the risks of this*.

The nature of the fertility control methods affected the level of risk participants were willing to tolerate. One important property of the method was its specificity. *The issue for me is the specificity of the method, because it will alleviate a lot of the risk* (E). Another was the effectiveness of the method. *If we can be certain of success people will accept higher risk* (E). *If it only works in the short term, and does not eradicate possums, why take the risk?* (O). *If you're going to pick a biocontrol, it will be one of the effective ones, rather than one with marginal impact on possums* (E). The nature of the risk was also seen as important. *If the risk is to indigenous flora and fauna there will be a lot of opposition to it. If the risk is only to another introduced species, I don't think there will be that same concern* (E).

The need for certainty was stressed by some participants. *If we could get a 100% guarantee of safety we would be happy* (P). In the Men's group, one participant claimed: *scientists need to check out everything that might go wrong*. Another participant countered: *but you are asking for the impossible. You can't have 100% certainty. It would be much more honest to say these are the risks*. In the Ethics group, the difficulty for scientists was mentioned: *at the moment the public are*

very worried, they want absolute guarantees and we can't give it. And a member of the Scientists group observed that you *can never remove from the public mind that uncertainty of what might happen*.

The burden of proof was an issue for one participant in the Environmentalists group:

> *What worries me is we keep hearing "there is no proof that this is harmful". I don't want to hear that, I want to hear, "we have done the research and we can now prove that it is not harmful". When we get to that stage, I'll clap my hands and say, "yeah, I agree with genetic engineering".*

The participant was well aware of the corollary of their position (that scientists can't prove this), and claimed it was a reason not to have genetic engineering. Such a burden was also mentioned in the Ethics group: *is it ethical for scientists to release a mechanism to control possums, about which scientists cannot guarantee its long-term safety and effectiveness?*

The question of whether there were some risks that people will not take no matter what the countervailing benefit was examined. Only two such risks were mentioned in the focus-group discussions: *I would not accept a risk of sterilising the human population* (M) and *I would have problems with interfering with the whakapapa of a native plant* (I). Members of the Iwi group were clearly willing to consider the risks, as the following comments by two different members of that group indicate. *I wouldn't have a lot of problems with GE to get rid of possums. I'd take a greater risk to get rid of possums* (I). *Some things are non-negotiable, in other things the benefits outweigh the downsides. I don't see any of this as non-negotiable* (I).

The Opponents group claimed, however, that *we don't know how to analyse the risks of GE*. Another member of that group went further:

> *I talked to a chap who does risk analysis on the nuclear weapons industry in America, and that whole thing, and he'd done some pretty fine risk analysis on it, down to point zero zero something of a risk, which was minuscule, . . . I said, "what's your perception of GE as far as risk is concerned?", and he said, "don't go there, it's too risky", and this is a guy who's dealt with the American weapons, you know, the whole military nuclear arsenal, and yet about GE he said we don't know enough.*

The Ethics group suggested a list of safeguards: *due care*, *minimise risks*, *consider others*, *don't rush it*, *the ERMA process* (described in the section on process issues), and *trials in containment*.

A commonly discussed example of the risks of genetic engineering in possum fertility control was a genetically modified plant being used to distribute the biocontrol to the possums. This had been described in the PCE information pamphlet. It was discussed in four of the groups (Women, Scientists, Iwi, and Opponents). 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 unforeseen 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*.

Trust

People don't trust genetic engineering, according to someone in the Provincial group. They also don't trust genetic engineers. Some groups described how *scientists have let us down too many times* (P). *Scientists have made some bad mistakes in the past. This is why I'm worried about genetic engineering* (C). Examples included breast implants, thalidomide, and Agent Orange. Rabbit calicivirus was mentioned as an example of people taking things into their own hands and

ending up with failure. The Industry group observed the lack of trust in proponents: *if you are opposed to genetic engineering you will trust only the strident opponents*. Scientists were described in the Opponents group as arrogant: *if we're trying to research any of it we need to know what we're doing. What has happened over the last few years does not inspire confidence. The testing just doesn't happen. The precautionary principle is not being applied*. Biotechnology companies were described as being interested only in profits: *pharmaceutical companies put profits above anything else* (P); *Monsanto trying to make money, trying to ram it down our throats* (M). Someone in the Provincial group even suspected a conspiracy: *some employers hide research findings if they disagree with them*. Motives of scientists were regarded as important, along with the source of their research funds and who their employers were.

The lot of scientists was recognised as not being easy: they *are told what to do by their funders* (P) and government scientists *are not independent any more* (P). Scientists did not have a good image: people *see on TV images of scientists making clones, creating bodies in test tubes* (W). The integrity of scientists researching fertility controls was, however, championed by someone in the Men's group: *these guys are not money-driven. They're doing it with the national interest in mind. You can trust what they are going to tell us*.

The groups considered the most useful way to maintain public trust was to use an open process to make decisions about biotechnology. This is discussed later, in the section on process.

Knowledge and Research Issues

Members of public focus groups recognised that they know little about genetic engineering. However, *public understanding is catching up with scientists* (O). Further, there was some scepticism about the extent of scientists' own knowledge about genetic engineering and DNA. *Scientists don't understand it either* (P). *They say they have almost mapped the human genome, strongly implying they know what everything does, but they have only given it a name* (O). This was of concern: *if genuine guys are researching it and finding problems, are there unforeseen problems with GM* [genetic modification]*?* (M). *It's scary, nobody knows exactly what could happen. There is a lack of information, even the scientists don't know how it will affect things in the long run* (I). Because of this lack of knowledge, *this science is very grey. We need 20 years more study on just the basics of GE before we can even look at something like this* [a transgenic plant] (O).

The need for long-term research, involving several generations of possums, before the release of a genetically engineered possum control would be acceptable was mentioned by several groups: *need long-term research, two or three generations of possums as a minimum* (P); *at least 15 to 20 years of research* (P); *you're still looking at generations, you won't know for years* (W); *we have done some short-term research, but we don't know the long-term consequences* (E). Scientists had to make sure they did not succumb to any pressure and *rush it onto the market* (P): *we look for quick-fix solutions, we don't give them the time to measure the effects down the track* (P).

A participant in the Men's group was very cautious: *Scientists have to research it to the point where they have looked at every possible scenario where it might go wrong and we feel comfortable that it won't*; and *there's still 20 years of research before scientists know it's safe*; and *I want to know that scientists know it's safe, because I don't know enough about it to say anything at this point in time*. However, *science has a snowballing effect. You* [the biocontrol scientist] *said it would take 20 years. I think in 5 years it will take another 10, and 2 years after that . . . It won't take 20 years if we target the non-GE biocontrol and put the research into it. Don't target the risky one, give it to the one we see as the least risky at this point in time* (O).

Suggestions for necessary fields of research were made in the groups:

- *effectiveness* (P);
- *the dose required to infect* (S);
- *when to release it, the right time of year* (S);
- *infective agents, as well as biocontrols* (S);
- *possible future effects* (P);
- an *indication of mutation* (P);

- the *development of immunity* (P);
- *cross-species risks* (S), including *birds* and *native plant species* (I);
- a *full costing*, which decision makers would require (S); and
- *how you take the public along with you?* (S).

Two groups suggested research protocols. The Provincial group suggested *multi-independent testing*, with *no collusion*. This would involve *three organisations working blind*, so *if just one test out of three raises doubts, then don't go any further*. The suggested approach in the Women's group was to test in the laboratory first, *then on an offshore island infested with possums*. This way, *you've got a trial situation so you can see what happens, make sure if you put a plant in, it does die off*. This *may take a few years, but it's been tested before you put it out in the population*.

Laboratory tests were recognised as being different from field tests in some groups. *Letting something loose in the environment is very different from a contained use. If a contained use goes wrong it will affect very few* (N). And:

> *We don't have 90 million possums in laboratories, we have 90 million possums in forests . . . Because it's going out into the environment, it will be out in the environment, and once it's out there, you don't have a recall button. . . DNA doesn't like being recalled back to the lab* (O).

A member of the Iwi group *discussed a proposal with my runanga. We accepted it because it was very controlled. I'm not sure my runanga would accept the next step, putting it out into the field*.

No participant, in any group, said they wanted genetic engineering for possum fertility control research stopped. Someone in the Environmentalists group remarked, *we can't decide whether it's worth researching until we have done the research*. Other comments included: *don't hold back on research* (N); *I believe in knowledge* (P); and *for GM food and biocontrol, keep it in research, not in the field* (O). One of the Industry group participants sounded a caution: *I'm happy for scientists to continue researching genetic modification, but be aware that money might be wasted if people won't accept its use*.

Process Issues

Informing the Public

The final broad issue raised with the focus groups was processes for making decisions on the development and use of a fertility control for possums. Many participants expressed a strong desire that more information be provided. Frequently, they said the public needed to be kept informed. Keeping the public informed was important for two main reasons. One was that the public deserved to know: *people should know what's happening* (W); *people don't have enough information* (S); *we don't get the right information* (P). The other reason was that the public needed to know, to avoid an outcry and to increase the likelihood of public acceptance of a fertility control: *make sure the right messages are getting across* (W); *when the decision makers do make their decision, they need an informed public* (N); *take people along with you, while doing the research, so they are more likely to accept it* (S); *we would trust the scientists more if we had progress reports* (I); *the public was left behind with GMOs, it hit them cold* (I); *if people are aware of what's happening, you will get a better response* (I).
Information was required on several matters. One was the existence of the "possum problem": *ordinary New Zealanders are not being told what damage possums are causing, . . . they are not being told how much forest we are losing* (I); *if the public came to despise possums as much as they despise gorse, introduction of biocontrol will be easier* (N). Information was also required on the progress of research: *keep us in the loop, keep us informed so we are not shocked when an application comes in* (I). Information on possum biology, such as the relatively undeveloped state of early pouch young, was also important: *that would need to be told to the public in advance, rather than in response to an outcry* (E). Information on possum control operations was also wanted: *I didn't appreciate them spraying possums in my area without telling me* (W).

Participants gave several examples of particular information needs, including:

- *what the possum problem really is* (W);
- whether possums really are *the problem they claim to be* (P);
- *the costs of doing nothing* (P);
- *where does the possum get Tb?* (P);
- *do other animals cause Tb?* (P);
- *how do you tell if an animal has Tb?* (M);
- *why are we targeting possums?* (P);
- *what could possum meat be used for?* (P);
- *who will financially benefit from biocontrol?* (P);
- *is fertility control going to work?* (P); and
- *will it affect other species?* (S).

Participants called for transparency in the provision of information: *needs to be transparent* (M). There needed to be *no hidden agendas* (P). *All the science should be made available, it should not be tucked away in secret archives* (P). It would help if information could be provided to *explain why some methods have been rejected*, this would *build up public confidence* (N). A *more comprehensive strategy for getting information out* was needed (N). According to the Industry group, information needed to be provided by someone who is *proactive*, who is *seen as independent* so *people can build up trust*.

Information could also be used to change people's attitudes. The Environmentalists group was particularly keen on this, giving several examples of people changing their attitudes toward conservation issues, such as:

> *When I was running track gangs for DOC . . . I had these big 6-foot guys with tattoos that had been in Mt. Eden down on the track saying, "we can't cut this piece of track, there's a little native orchid down here".*

Simply providing information was not seen as a complete solution, however, because it would not necessarily change people's attitudes in a consistent way: *the assumption that, by educating people, everyone is going to come out with the same idea, is incorrect. You will still get a range of opinions and have to deal with that* (E).

Some participants were concerned about media manipulation in the presentation of information. Manipulation could be done by either pressure groups — *the groups involved can distort the claims* (W); *things provided through the media can always be slanted. It's hard to present just the facts, rather than portraying the facts* (O), or the media themselves — *people like Paul Holmes stir things up* (N); *media want an angle, you are trying to inform the public, but you are cornered into a media angle, . . . media don't want to know about the message, they want to know about the controversy* (E). And, even if manipulation was not intended, *Federated Farmers and Forest & Bird counter each other's arguments. The person in the street doesn't know who to believe* (I).

To provide information, *a toolbox of techniques* was needed (C). Although someone in the Ethics group suggested that an *appropriate level of medium* was required, somewhere between the mass media and the professional scientific media, participants in some groups thought the mass media could be used to good effect. The Women's group suggested a *TV documentary of what it is and how it works and what you intend to do*, because *if you just stick a question, "would you like biological control of possums?", the majority of people would say "no way"*. Someone in the Ethics group claimed that *telling people the issues is not the best way. Raising the issue on a popular TV programme, like Shortland Street, needs to be taken seriously*. Websites, weekly or monthly magazines such as the Listener and North and South, radio programmes like Kim Hill on National Radio, displays in shopping centres, and a presence in schools were suggested.

The point was made in several groups that, even if information was provided, people would not necessarily read it, or take notice of it. *How many people are going to look at a website?* (M). *Most people would put junk mail in the bin* (W). *New Zealanders don't take any notice of something unless it's on top of them* (S). Also, people might not want to take notice of the

information: *half the population won't change their mind, no matter what you tell them* (M), *there will always be people who don't believe you* (N), and *people will only trust information if it supports what they think* (I). The best method was to *approach the public by giving them the situation, not the solution. People would want to know about it then* (M).

Involving the Public

In several groups, but particularly the Ethics group, the idea was raised that simply informing the public was not enough, the public had to be actively engaged in debate. *We have a duty to inform the public and provoke public discussion and, even if people don't want to think about it, they should be encouraged to* (E). *The proper functioning of a democratic society requires a reflective and informed citizenry* (E). The public was not always compliant:

> *Instead of talking about Joe Public out there as an undifferentiated group, you actually need to realise that there are a lot of people with different ranges of expertise out in the community, and if you try to pull the wool over somebody's eyes, the chances are you are going to find somebody who knows more about it in that particular area than you do, and they will get at whatever you are putting up and tug it so that they unravel it, and that's where you then lose the confidence of the community at large* (N).

An *open process* for debate and decision making was seen to be required; *people involved in doing the research need to explain it to people before there is an outcry* (E). *People need to have confidence in the process, how is the decision being made, rather than a need for trust in the person making the decision* (E). In some groups, the Office of the Parliamentary Commissioner for the Environment was seen to be in a position to play a role in the process. The cost of keeping the public *up with the game* might be *much less than the cost of reacting to an outcry when someone digs up your experimental cabbages* (E). Some participants described the series of focus groups as a good example of the kind of process that was required: *having these discussions is part of the process* (E); *what you're doing now is a good thing* (W).

Appropriate Decision Process

An appropriate process for making a decision on the introduction of a fertility control for possums was seen as one that had roles for both the public and experts. In several groups, the idea that the public should make the decision was raised: *it's a national situation, we should all get involved in the decision* (M); *community as a whole needs to make the decision* (C); *the people who have an interest in this aren't just the people who have a problem with possums, we all have an interest in this* (O). A *national referendum* was suggested in the Women's group. Another suggested approach was to *present the public with a series of options, and let them make up their own mind. The public might decide to live with the possums, perhaps because of the uncertainties with the control methods* (S). There was a *need to ask people the questions in the right context and scale, break it down into regions to make the decision*, because *people can't make sense of it at a national scale* (S).

Although *public participation in the final decision* (O) was called for, *you could never educate the public enough that everyone could make an informed decision* (M). This was because *some people won't want to participate* (O). One participant said *people want information and the ability to choose, and to feel that their beliefs and ideas are having some influence*, then personalised their comment: *I would like to know what's going on, so I can make an informed choice* (E). Public participation in the decision was not automatic: *we have to seek out opportunities to be involved. If we weren't involved with RAGE we wouldn't know this was happening* (O); *we didn't get a chance with RCD* (O).

Experts were also seen as having a role in the decision process: *needs scientific expertise, which you won't get from lay people* (O); *not an issue to be resolved by a democratic process, although the public does need to be informed* (S). Someone in the Men's group suggested: *we don't need a referendum. The Health Department doesn't hold a referendum every time they make a decision on a drug. They have people test drugs and they approve them*.

The government also had a role: *nobody else could research it* (C); *possums affect all of us, the heritage of all New Zealand. The government should take the lead* (I). Someone else in the Iwi

group suggested that there was a need for *Crown funding to fund it, but not necessarily government taking the lead*.

In any case, any experts involved in making the decision had to be people who enjoyed public trust. A need was expressed for *absolute confidence that people making the decisions on your behalf are doing it ethically* (W). A lack of trust in scientists was expressed in the Men's and Opponents groups: *I don't think we should trust the scientists* (M); *too many dishonest scientists, giving the profession a bad name* (O). However, even within those two groups, not all scientists were seen as not being trustworthy: *not all scientists are corrupt, they are just focussed and blinkered, they are not being funded to go outside those areas* (O); *I'd be confident if a group of scientists worked on the problem for a number of years and said they had looked at all the possibilities they knew of and this is the risk, and if the risk was palatable to me I'd say go ahead* (M). A need for *independent funding sources for scientists* was expressed in the Opponents group.

Members of the Opponents group explained that one of the reasons for their lack of trust in scientists was the vested interests of their employers. *There are vested interests, that's why we see so much research going into chemicals and GE, there may not be any money in other controls for these companies because they don't have patents in that area* (O). And: *we've had a lot of research by corporations wanting to make a fast buck. The easiest bit about GE is working out how to do it, but there's no money going into seeing what the other effects might be, the ecology. They're oriented toward results, not safety* (O). Large corporations were not the only bodies with vested interests: *CRIs* [Crown Research Institutes] *are pro-GE because that's where they're getting their money from* (O); and *universities have to make money now* (O). These vested interests meant that the power relations between proponents and opponents were unequal: *GE companies have millions of dollars to throw around. I don't have that sort of money, the balance has to be redressed* (O).

A proper process also needed checks and balances. One reason for this was that *people who are affected by it, at the coal face, are more willing to take risks and to heck with the consequences* (W). Several safeguards were suggested, including: *government controls* (M); *an accountability committee of people chosen really carefully by the public, a range of people with a wide range of skills* (W); *need someone who is neutral, to judge the vested interest* (E); and *find people who are strongly opposed, so they will ask all the hard questions, then get people like yourselves to come back to us with the answers. This process would take a lot longer than it would to get a commercially acceptable result, but that's not what we're looking for here* (O). The Parliamentary Commissioner for the Environment was suggested as someone who was *non-partisan* (I) and *independent, theoretically* (O).

Members of the Ethics and Opponents groups had had experience of the Environmental Risk Management Authority, ERMA, which was set up under the Hazardous Substances and New Organisms Act 1996 to make decisions on the testing and release of genetically modified organisms, among other things. There was a feeling that *ERMA is not doing a good job* (E). This was because *ERMA's remit is a bit narrow* (E). Some examples of this narrow remit were given. *They don't attempt to look at the ethical issues, it's not within their decision-making process to weigh up that evidence against the scientific evidence* (E). *They ask for specific technical reasons why you're opposed to things, they're not considering spiritual and ethical reasons* (O). *ERMA has said they are there to administer the Act, not to look at the bigger issues. And it's the bigger issues that the public are concerned with, not the technology but its consequences* (E). *ERMA were set up to prevent and manage risk. They haven't done any prevention. They have only managed risk, with controls we see as inadequate* (O).

Questions that Need to be Considered

Participants were asked what they thought were the important questions that needed to be considered when deciding whether to research and develop a genetically engineered fertility control for possums. The Environmentalists group was the only one to itemise a list of questions. They were:

- *side effects*;
- *by-catch*;
- *impacts on other species*;
- *impacts on the ecosystem*;

- *will residual amounts sit around?*;
- *downstream effects on waterways*;
- *cost*;
- *ease of application*;
- *is the animal suffering, either in tests or field use?*;
- *feed-on effects in Australia*;
- *impact on evolution of ecosystems in the long, long term*;
- *is it irreversible?*;
- *is there enough surety of funding to make the research worth starting?*;
- *who is the research for? Unemployed scientists? Overseas companies with spare capacity? Getting rid of possums because we want to save the habitat?*;
- *why are they funding it?*; and
- *who is going to benefit*?

One approach suggested in the Environmentalists group was to establish a set of *ethical tests*, involving the kinds of questions given above, that could be prioritised and weighted. Different possible control methods would be subjected to these ethical tests. In any case, the Environmentalists group urged caution: *proceed with caution. When in doubt, do nothing*.

Reactions to Information Pamphlet and the Focus Group Research

Participants' reactions to the PCE information pamphlet were mixed. Some said it was just right: *informative summary* (S); *just right for a layman* (M); *gives you options for discussion* (P). Some said it gave too much detail or was too hard to read: *any more and I wouldn't have read it* (M); *25 paragraphs too many* (M). Some said it was too vague: *nothing about the hows, whys, what's been done so far* (P); *doesn't say what would happen next* (C). Although the pamphlet included some commonly expressed concerns about biotechnology, as well as information about the possum control methods being researched, the most common criticism was that it was not balanced. This comment was made in several groups. *I felt it was "death to the possums"* (M). *A "snow job", leading the reader to one inescapable conclusion: if you want to get rid of possums and you don't believe the current methods are working, use GM* (C). *It reads to me like biotechnology's a good idea* (O).

Members of the Provincial group, the only group to have two meetings, were asked whether their views had changed between the two meetings. The main comment they made was that, having been given some information, they wanted to know more.

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Appendix 1: List of topics covered in focus group meetings

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.]

   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?*

5. 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?

6. 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?

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

8. 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?

9. Wind-up.

Appendix B

The development and use of innovative technologies for the control of possums in New Zealand - an introduction to the ethical implications

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Summary

Possums, introduced into New Zealand in the 19th century, are today regarded as a serious animal pest, threatening New Zealand's biodiversity, by damaging and destroying native flora and fauna, exotic forestry, horticulture and crops and harbouring diseases of humans and farm animals. Attempts to limit this damage largely involve trapping, shooting and poisoning possums. There are problems with the efficacy, cost and acceptability of current methods, and therefore biological controls are being developed. However, these innovative methods are raising questions of safety and in some instances of the appropriateness of using gene technology in this situation.

As with any contentious issue, the morality shared in common (respecting the freedom of individuals and our rights to make our own choices, being fair, not causing unnecessary harm, and doing good) provides a starting point for considering whether innovative means of controlling possums are acceptable. It is important to consider the control of possums from a number of levels, since all will ultimately impact on the acceptance of biocontrols.

Responses to the damage caused by possums are to do nothing and accept the long-term changes in our environment, or to reduce the damage by reducing possum numbers (the focus of present control programmes) and/or affording protection against the harmful effects of possums. Factors such as which are the ecosystems and livelihoods we value, and whether it is right and important to kill animals, impact on these responses.

Accepting that there is a need to protect the environment, and that killing possums is justified, there are conventional and innovative means of reducing numbers. Shooting, poisoning and trapping may be ineffective and unacceptable in some circumstances, necessitating the development of new means of control. Among these are biocontrols, hailed as safe, effective and inexpensive means of managing pests. However, biocontrols too may have unintended consequences on non-target organisms and ecosystems requiring careful consideration. Finally, biocontrols may be developed using gene technology, raising both intrinsic concerns (is altering organisms in this way natural?) and extrinsic concerns (public and environmental safety, animal welfare, and social and economic harms and benefits), issues with ethical dimensions.

This analysis, which is a limited perusal of the moral and ethical aspects, suggests that an exclusive focus on developing biocontrols using gene technology, is founded on a number of generally challengeable assumptions.

- Conventional means of controlling possums are ineffective and unacceptable to many people. Given the cultural factors (e.g. fur prices) which impinge on the success of these means, it may be possible to explore the creation of a social environment in which some of these methods are more reliable and acceptable.
- Biological controls are a preferable means of dealing with weeds and pests. A critical examination of the value of this approach is required so that we are fully aware of the possibilities of unintended consequences.
- Gene technology is an acceptable method for developing innovative means for reducing possum numbers and therefore environmental damage. Clearly, this is a subject of contention for many and varied reasons.

The acceptance of innovative biological controls to reduce the damage caused by possums depends then, on a number of issues. Whether gene technology is determined to be the most appropriate means of control will depend on open and informed discussion by all interest groups.

Introduction

Brushtail possums were introduced into New Zealand from Tasmania and mainland Australia in the 19th century. Although early damage to orchards, gardens, crops, grasslands and forests was identified, it was considered negligible compared with the commercial advantages of a fur trade. However, the adverse effects of the animal soon became evident and large scale control operation began in the 1950s (Cowan, 1990). Today, possums are regarded as a serious animal pest, threatening New Zealand's biodiversity, by damaging and destroying native flora and fauna, exotic forestry, horticulture and crops and harbouring diseases of humans and farm animals.

Attempts to limit this damage largely involve trapping, shooting and poisoning possums. However, there are problems with the efficacy and acceptability of these methods, and alternative methods of control are being investigated. Most involve the development of biocontrols – the use of transmissible biological agents such as parasites, viruses or bacteria – rather than chemical or physical means. These organisms can also be modified to make them more virulent or to deliver a poison, or have some other trait such as render the animal infertile. There is now some public expectation, albeit invoked by the efforts of the science and pest management sectors, that biocontrols are a suitable means of controlling a range of weeds and pests, including possums. On the other hand, there are public concerns about the safety of biological controls and of genetic engineering, a technique underlying the development of some of the proposed biocontrol methods.

A failure to gain reasonable public acceptance of fertility-based technology may preclude the use of such technology. This is because while technology may make many things possible, it is the social, political and cultural context that determines the acceptability of that technology. Acceptance and regulation of biocontrol technology will depend on some sort of dialogue and perhaps consensus on a number of issues, such as: pest control and the treatment of wildlife; animal welfare; biotechnology and genetic manipulations; environmental impacts; and social consequences. With gene technology especially, there is an argument for those in research and development being required to consider the possibility of unwanted consequences of technology. In failing to recognise these and other ethical dimensions of technology, for instance, the rights and autonomy of others, the science community alienates the general public, thus increasing mistrust (Thompson, 1998). Furthermore, there is likely to be a range of arguments of varying strength and relevance both for and against possum biocontrols, and it is essential these are identified, clarified and opened up to debate. In other words, consideration should be given to the morality and ethical contexts of using genetic engineering and biological organisms to manage possums.

Anticipating public controversy, and conscious of the problems that led to individuals resorting to illegal action to introduce the rabbit biocontrol RCD (Parliamentary Commissioner for the Environment, 1998), the Parliamentary Commissioner for the Environment (PCE) began a project to investigate public attitudes to the possible future use of possum fertility controls. The project's objectives were to:

1. examine attitudes among different groups of New Zealanders to the possible future use of biocontrols, including those involving genetic engineering, to manage the risks posed by possums to New Zealand;
2. examine information needs for debating biotechnology needs among different groups; and
3. develop processes for meaningful public debate and input into biotechnology and genetic engineering issues.

The project involved a Reference Group, comprising people from an array of backgrounds, as well as staff from Manaaki Whenua Landcare and AgResearch, the two Crown Research Institutes working on possum control research. In addition, a number of hui and focus group meetings were held around the country, including an Ethics group held at Massey University on 24 November 1999.

The present contribution, prepared as part of the PCE's investigation, uses an ethical framework developed to explore some of the contentious issues in science and agriculture (M.W. Fisher,

unpublished). This approach has been used to both (1) validate the usefulness and relevance of an ethical approach; and (2) consider the ethical implications of the development and potential use of possum biocontrols.

The focus of this paper then, is to provide a general overview of the sorts of ethical issues relevant to the use of biocontrols to manage the effects of possums. To begin with, it is necessary to identify the problem.

The possum problem

Although commonly perceived as too many possums – "New Zealand's number one public enemy" (Jolly, 1994) – the problem is really of their impacts and the damage they inflict on the environment. The effects of possums include the destruction of native and exotic flora and fauna, something regarded as of significant national value, the economic impacts and risks, and the threat to animal and human health and wellbeing through carrying diseases. Given the problem exists, there are a range of possible solutions and these have been outlined in Figure 1. Simply, we can do nothing and live with the consequences; protect against or compensate for the environmental and other damage; or reduce the damage by reducing the numbers of possums.

Do nothing

Doing nothing entails accepting the long-term changes in our flora and fauna that possums might cause, a debate about what ecosystems we value. Do we know whether the population and the environment will stabilise at some time in the future, and what the resultant environment might then look like? Given New Zealand's conservation ethic of preserving the diversity of native forest and fauna this option (explored by Fitzgerald *et al.*, 1996), and the potential effects on New Zealand's trade from the risk of bovine tuberculosis in our cattle and deer herds, this may not provide a realistic solution.

Not doing anything could result in harms such as a reduction in biodiversity as possums eradicate certain plant and bird species; in the poor animal welfare if and when numbers exceed the carrying capacity of the environment; and in visitors to the forest not being able to experience the environment as it was prior to possums becoming established in New Zealand. There could be a need to modify social expectations to accept some levels of possum-induced risk or environmental damage. On the other hand, resources currently being used to control possum numbers and research into new control methods would be freed for other uses; and the animal population maintained as a natural resource for present and future industries (e.g. fur and trapping). It might also promote the concept of humans learning to live with nature, be it exotic or indigenous, if this is something valued by society. In a world characterised by hunger and poverty, should not the possum be considered as an important natural resource rather than a pest?

Reduce possum damage

Reducing the environmental and economic damage caused by possums is the primary aim of control programmes. There are a number of facets to this approach, including reducing possum numbers, addressing the problems of possum-carried disease, especially bovine tuberculosis, or perhaps protecting or modifying the affected flora and fauna so that excessive possum numbers might not affect them adversely. Although, open to objections regarding the manipulation of native species and the technology necessary to do so, has the possibility of, for example, making native trees relatively unattractive to possums been considered? Similarly, animals and humans can be protected from some diseases carried by possums such as vaccination against tuberculosis. Can possums be "domesticated" such that the population never exceeds some sustainable carrying capacity? In other words, can we control or minimise the effects of possums without having to resort to killing, either to reduce numbers or to eradicate them completely.

Reducing the numbers of possums

The most common approach to possum damage is to reduce possum numbers. This approach raises a major ethical question - is it right to kill possums, or reduce their fertility so that fewer might

inhabit our ecosystems? Are there differences between killing animals outright and preventing them from reproducing? Though there are many and varied contributions to these questions, including the view that it is wrong to kill animals (e.g. Regan, 1983), the relationship between mankind and animals has yet to be realised in philosophy and ethics (DeGrazia, 1999; Fisher, 2000). However, the view dominant in our society, reflecting a long tradition of moral reflection, is that it is appropriate to kill animals providing that it is justified and undertaken humanely (e.g. Banner *et al.*, 1995). Nevertheless, possums are sentient (albeit exotic to New Zealand) and it matters to them how they are treated in New Zealand. Therefore, we should not cause any harm without reasonable justification (some harms may not be justifiable) and if there are ways of minimising that harm, then they should at least be considered, and utilised to ensure the least harm or suffering to the animals concerned.

Thus, there is a range of responses to excessive possum numbers with the most practical or feasible being dependent not just on scientific or technical knowledge, but also on social, political and cultural viewpoints. Whether these have been comprehensively explored is at best debatable but for the sake of argument, it is accepted that there is a need to reduce possum numbers.

Given that it is acceptable and necessary to kill possums (or reduce their fertility), there are a number of methods that could be used. These include the conventional shooting, trapping and poisoning methods, as well as the proposed innovative biotechnological methods. A question common to all methods is what is the interaction between, and to what level would possum numbers have to be reduced to protect, (1) animal health; (2) human health; (3) economic livelihoods; and (4) the environment?

Conventional methods

There are several current options for reducing the possum population, including shooting, poisoning and trapping, methods which will likely to continue to be used in conjunction with any future biocontrols. The effectiveness and acceptability of these methods is, apparently, questionable in some circumstances. For example, possums readily become bait-shy if exposed to sub-lethal doses of poison, some poisons may compromise animal welfare and some may endanger non-target species, and shooting and trapping may be uneconomic, especially in difficult terrain. While shooting, trapping and poisoning are at least partially effective means of controlling possums, it is because of their perceived ineffectiveness, as well as cost, animal welfare, environmental safety or human safety concerns, that other methods are being proposed. The ethical aspects of the conventional means of managing possums could be the subjects of further consideration. For example, trapping and shooting can be used strategically, with the by-products of the control (the fur or carcasses) being used for clothing and meat, etc, whereas some biological means may be more indiscriminate with carcasses unable to be easily recovered. The development of a more humane possum trap, or the withdrawal of an inhumane poison, might alter the perception of the need to come up with innovative technologies.

A variety of economic and political forces impinge on the effectiveness of some of these methods e.g. trapping is dependent on factors such as international fur prices and the practical logistics of managing projects. Therefore, it would seem pertinent to fully explore the creation of a social environment in which these methods are more effective on a long-term basis. This is beyond the remit of the science community, yet should not be abandoned in favour of a scientifically based technological solution without critical consideration. Could public resources be used to improve shooting and trapping programmes to the point where they become both reliable and effective means of reducing environmental damage in both accessible and rugged terrain?

Innovative methods

New technologies for killing possums can be either similar to conventional means, e.g. new traps or poisons, or the somewhat more innovative (and currently popular – the "hype and glitter" but as yet unproved) biological means such as virally-vectored immunocontraception (Tyndale-Biscoe, 1994). Assuming the innovative yet conventional raise similar ethical issues to current conventional poisons and traps etc, I shall concentrate on the proposed innovative biological or biocontrol methods.

Biological control methods

Biocontrols are increasingly seen as safe, effective and inexpensive means of managing pests. Rather than chemicals, seen to be working against nature, biocontrols are promoted as working with nature. It may be important to differentiate between biocides and biological controls, and between the different methods of biological control. The latter include control of a pest organism by another, naturally occurring organism; increasing or enhancing the effects of that naturally occurring organism; the introduction of an exotic agent to control an exotic pest (this method has generated some of the most spectacular successes, as well as the most spectacular disasters); and the control of native pests with exotic agents (Lockwood, 1996).

However, biocontrols also have their darker sides (Miller & Aplet, 1993; Hamilton, 2000). These include not working, having unintended consequences such as unacceptable suffering in the target animal, damage to non-target species and the generation of new pests, and the potential to permanently, cumulatively, and irreversibly alter ecosystems. The introduction of ferrets, weasels and stoats to control introduced rabbits is just one such example from our past attempts of biocontrol. There is also the potential for a biological control treadmill in which new organisms are continually introduced in order to overcome the problems associated with earlier introductions (e.g. Ferguson *et al.*, 1994).

In short, biological controls require critical examination (Lockwood, 1993, 1996; Miller & Aplet, 1993), especially since their attractiveness is founded on arguments that they will be safer, sounder and more sustainable (including less expensive) than current physical and chemical means of pest control. It should be noted that these claims have seldom been tested or even able to be tested. Though biological controls may be accepted as advantageous, it is clear that such acceptance is not currently based on a thorough critique of the evidence. An international perspective (Lockwood, 1997) indicated that there were a number of major unanswered questions:

- how should biological controls be applied and regulated in the face of persistent ecological uncertainty regarding environmental impacts?
- how are human and ecosystem risks and benefits balanced?
- who should study and regulate biological controls?
- how can benefits and costs be fairly distributed? and
- should biocontrols be evaluated against conventional control methods?

Key questions relating to New Zealand possums would include; is there a risk to non-target animals and species (including Australian possums); is it possible to rectify the damage if the biocontrol proves harmful; can the biocontrol be withdrawn from the environment if it proves to have deleterious effects; what effect will it have on New Zealand's international image and the viability of our exports; what happens if and when possums adapt to biocontrol methods. Clearly, the possible introduction of a biological control requires considerable thought, independently of whether or not it uses innovative methods such as gene technology.

Innovative biocontrols

The use of innovative gene technology to manage possums raises many varied and complex issues – in short it is contentious! Generally these issues can be grouped into either intrinsic or extrinsic concerns (Straughan, 1995a, b).

Intrinsic concerns with gene technology

Intrinsic concerns relate to whether genetic engineering is right or wrong in, or of itself, regardless of the potential positive or negative consequences. Strands of this argument include the often held views that nature is sacred, that genetic engineering interferes with nature and is therefore wrong; that anything natural is good, that genetic engineering is not natural therefore it is wrong; and that it unacceptably violates species boundaries and genetic integrity. Counter arguments include the views that to be human is to be part of nature; that the genome is not static but changes over time; that no single criterion for a species exists; that species boundaries are crossed using more traditional means (eg the mule bred from the horse and donkey) and that natural things or acts can also be bad (eg earthquakes, cholera and some genetic mutations). Interestingly, these arguments are not necessarily limited to genetic engineering, though the debate provides an opportunity to explore and expose them.

Though frequently raised, these arguments have yet to be shown to convincingly demonstrate that genetic engineering is morally and ethically acceptable in and of itself (Rollin, 1996). In other words, it is quite possible that we may not be able to determine whether gene technology is acceptable or not from these sorts of viewpoints - it is just that there are polarised conflicting intuitions (Ruse, 2000). Alternatively, the pursuit of a "right" answer might be thought to betray the nature of moral judgements.

At another level, genetic engineering may be thought of as disrespectful to and disruptive of the sacredness of life and of the environment. Furthermore, it prolongs the traditional mechanistic, domination view of agriculture when sustainability really requires a dynamic, ecological mindset. In a sense, this objection relates to the sort of people or community we want to become. Attitudes in society seem to be changing from those of Francis Bacon's when nature was to be dominated, into concepts of nature as something for humankind to value, nurture and participate in. On the other hand, increasing urbanization is changing our bonds with the natural world. What cultural ideals do we want for ourselves and our relationships with the natural world we inhabit, and how will controlling possums with innovative technology best contribute to those ideals?

Intrinsic objections probably account for much of the opposition to gene technology. However, it may be quite simple to work around some objections. For example, labelling produce or environments as GE-free or 1080-free, so that people have the right to exercise choice and may accept or avoid them for whatever reason. Conversely, they may require more substantial responses such as avoiding the use of human genes in the development of biotechnology.

Extrinsic concerns with gene technology

The extrinsic concerns relate to the consequences of developing (or not developing) innovative technological means of controlling possums. These are the more familiar arguments currently associated with biotechnology, standard critiques have tended to emphasise the effects on the environment and ecological systems, animal welfare, human health and safety, and the social and economic harms and benefits.

Animal welfare

The effects on animal welfare will perhaps be the simplest to evaluate, though it is important to keep in mind that animal welfare is not a science alone, but also involves common sense, subjective judgements, and ethics (Fisher, 1998). Whilst early attempts to genetically modify animals resulted in grossly unacceptably poor welfare (Pursel *et al.*, 1989) no significant effects have been reported in at least some more recently genetically modified animals (Hughes *et al*., 1996), though the long-term effects have yet to be investigated. However, this is not always the case and some genetic modification programmes have ceased because of harmful effects to the animals (see Dixon, 1995). A realistic ideal is that the animals should be no worse off for having been genetically manipulated (Rollin, 1995). Though a range of measures of animal welfare may assist in determining the acceptability of control methods, it is important to keep the context in mind. The purpose of pest control methods is to cause harm (death or impaired fertility) in a wildlife population (Warburton and Choquenot, 1999). Conversely, we now have a better understanding of the welfare requirements of possums, as a spin-off of scientific research into biocontrols (e.g. McLeod et al., 1997).

Environment

Environmental and safety concerns relate to how genetic manipulation and its products might have wider effects within the ecosystem. Concerns relate to questions such as what effect will the technology have on the food chain, will the gene transfer to non-target species, will spontaneous mutations lead to the evolution of new viral pathogens and pests, and what precautions are needed to prevent the introduction of biocontrols to Australia, where possums are valued? Do we have the right to modify the environment in pervasive ways, what responsibilities have we to other species and the natural world? What effects are expected on the intangible and spiritual dimensions of the environment, and on the cultural and traditional dimensions for tangata whenua? Will people in one community have any choice if the agent used in another region is readily transmissible? Finally, how do we balance the welfare of different ecosystems, of people and of the possums themselves (Marks, 1999).

Socio-economic

While technology makes many things possible, it is the social, political and cultural context that determines the acceptability of technology and thus the uses to which it will be put and the effects it will have on the world (DeWalt, 1991). Thus issues such as who benefits from innovative means of controlling possums and who carries the risk are important? Who should be liable for unforeseen and harmful consequences? If a biological control does successfully eradicate the majority of New Zealand possums, should those industries utilising possum products be compensated? Will people have a choice in determining which biocontrols are acceptable, for whatever reason? Some individuals, businesses and communities may benefit from the opportunities new technology provides, while others may suffer or may object on the grounds of their values and beliefs. It is important to acknowledge and consider the nature of these changing social relationships.

The debate about biotechnology is as much about power as anything else (Nicholas, 2000) - from the power to modify genomes and therefore life, to the power of culture's enforcing their ideals on others, to the power of multinational biotechnology companies influencing global environments. Issues of trust and integrity become increasingly important. Who should and do we trust? Individuals within society are becoming increasingly sophisticated in demanding the science community use "bold and daring" attempts to demonstrate claims of the safety of gene technology etc., rather than accept the view that there is no evidence to suggest gene technology is unsafe. These views impact on the trust extended to the science community to judge the extrinsic risks associated with gene technology.

Where to from here?

The present study is a brief account of some of the ethical issues to be considered in the use of gene technology to manage possums in New Zealand. It aims to highlight some significant points that need addressing. Most obvious are the needs for critical examination of the place of biocontrols in New Zealand pest control, and of the use of genetic modification in biological controls. Some of the sorts of ethical issues contributing to the rightful acceptance, or otherwise, of a genetically engineered biocontrol, are summarised in Table 1. This uses principles of common morality and should be seen as merely a starting point whereby we can begin to explore public acceptance from a foundation of justified moral standards and the appropriate knowledge. The next step to consider would be how different people might differently interpret or differently value these aspects by virtue of their disparate cultures, life experiences, ideals and world views.

We may all have different values (Rollin, 1996; Burkhardt, 1998) and worldviews in science, and there are many examples how these change over time. The Ptolemaic system placed the earth at the centre of the universe for many centuries, and this view was reflected in human values and expectations about our place in the scheme of things. In 1530 Copernicus' sun-centred solar system "threatened" that view and with it, the values and beliefs of the day. Holding this more radical view contributed to Galileo's persecution by the Church in 1633 for supporting a sun-centred solar system.

Currently, gene technology is based upon the view that DNA produces proteins, which in turn result in the physical or behavioural characteristics of the plant, animal or microbe, enabling it to interact with its environment. What if an alternative view was that an organism's genes were much more dynamic and perhaps even able to be actively and beneficially changed by the organism in response to changes in its environment (Rennie, 1993; Strohman, 1993, 1994, 1997; Ho, 1999). Accepting this epigenetic or "fluid genome" paradigm could result in genetic engineering being perceived as a "natural" mechanism whereby organisms are inextricably linked with their ecological environment. It would also necessitate a more sophisticated ecological approach to the understanding and use of "artificial" genetic engineering. In biology, as in other complex systems, interactions determine the effects of a particular modification, interactions at the level of the genome, the organism and its environment. We may not yet have the ability to perceive let alone monitor these interactions. It is suggested that seeing genetic engineering as natural would impact considerably on our current values. Similarly, whether we view the problem from an anthropocentric or human perspective, through a concern for sentient beings, or take an ecologically centred approach frames the ethical choices that we will ultimately make (Singer, 1997).

How these worldviews, and the stories we tell expressing our hopes and fears (e.g. Mary Shelley's *Frankenstein*), impact on our morality and decision making is currently the subject of ongoing investigation. Only time will tell which views are acceptable or "correct", or even whether any views can ever be classed as "correct", but discussion and acceptance of different views can only enhance our knowledge and our capacity to deal constructively with the issues arising from the application of new technologies.

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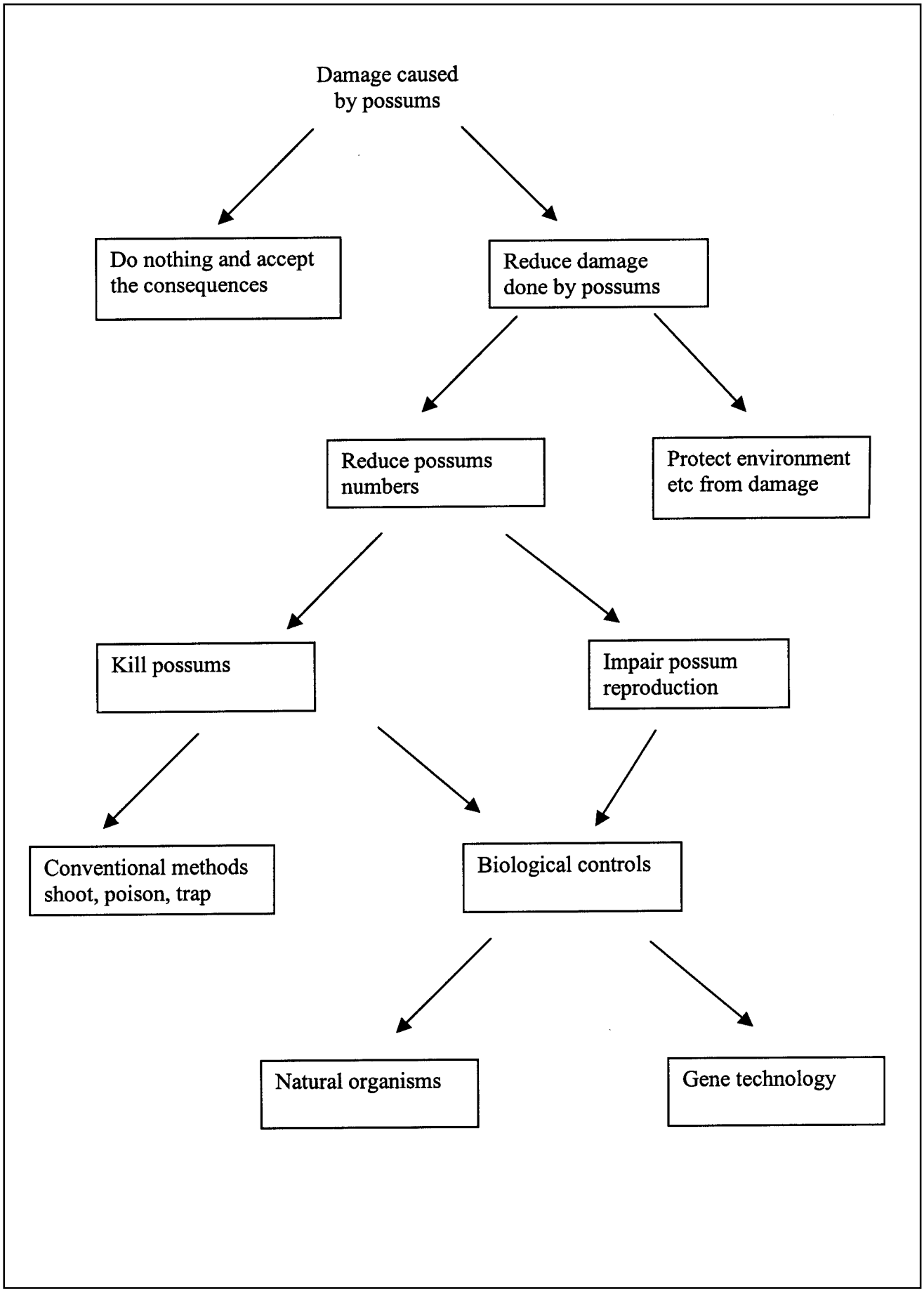
Table 1. A framework or ethical matrix based on common morality (see Mepham, 2000) used to help identify some of the issues associated with using a hypothetical biological control agent developed with some form of gene technology, to manage possums. A more comprehensive account of the issues was raised by the focus and hui groups (see Wilkinson *et al.*, 2000).

Moral standard	To not cause harm	To do good	Respect for freedom of choice	Fairness or justice
Interest group				
Possum	Causes death or infertility. Will there be any other "subclinical" effects?	May be less harmful than conventional controls	Do possums have a "choice" in being susceptible or resistant to biocontrols?	Is it in keeping with the integrity of the species?
Environment	Will the biocontrol be specific to possums? Can any unforeseen harm be rectified?	Less damage caused by possums. Maintenance of biodiversity.	Will a biocontrol be able to be isolated in particular environments?	Will it result in a more sustainable environment?
People	Industries currently using possums for resources may be penalised. Will gene technology harm those who oppose it for whatever reason? What happens if and when possums adapt to biocontrols?	Preservation of preferred flora and fauna. Protection of agricultural interests. What business opportunities will arise from the acceptance and use of biocontrols?	Will people have a choice as to which control means is available, and in certain localities?	Will excessive focus on biocontrols penalise those in favour of conventional means? Will a biocontrol and/or gene technology approach be treated fairly in international law and trade? Who will be liable for unforeseen and harmful consequences?

Figure 1. The range of theoretical solutions to the damage caused by possums



Appendix C

Possum Biocontrols - Information Paper

The Parliamentary Commissioner for the Environment is independent of government, advising on critical issues for New Zealand's environmental management. The Commissioner has begun a project to explore public attitudes to fertility-based biocontrol technology for possums. Biocontrol techniques have been identified as an important potential alternative for possum control. Scientists from AgResearch and Manaaki Whenua - Landcare Research are currently investigating these technologies. This pamphlet provides information on the options being considered.

Possums in New Zealand

Possums were introduced into New Zealand in 1858 to establish a fur trade. There are now tens of millions of possums living on more than 95% of New Zealand's land area and some off-shore islands. Their population density here is up to 20 times the levels in their native habitat in Australia.

Possums are New Zealand's Number One animal pest. They are a huge threat to our biodiversity. They eat the leaves, flowers and fruit of native plants, doing enormous damage to native forests by killing trees and other plants. They compete with native animals for food, they raid birds' nests, and they eat native snails and insects. They cause major damage to forestry, horticulture and crops, as well as to ordinary New Zealanders' gardens. The direct economic losses due to possum damage have been estimated to be as much as $60 million a year.

Possums also carry diseases such as giardia and cryptosporidium that may infect humans. They spread bovine tuberculosis to herds of cattle and to farmed deer, which is a significant risk for the overseas marketing of New Zealand products.

What is being done now to control possums?

At present the main methods for controlling possums are poisoning and trapping. The major poison used is 1080, used either in bait stations on the ground, or dropped aerially over large areas. New Zealand uses more 1080 than any other country in the world. Other poisons are also used here to lesser degrees, as well as several different kinds of traps.

Other possum control methods include:

- keeping possums out of a particular area (such as a special conservation reserve) with purpose-built fences;
- using sleeves around tree trunks;
- chemical and biodynamic repellents; and
- shooting possums.

Government agencies and councils spend more than $30 million each year on possum control with these methods. More is spent by private individuals, farmers and businesses.

Possum control employs many different kinds of workers including staff in councils and the Department of Conservation, pilots, factory workers and contract hunters. Possum skins and fur can be a source of income, especially in some small rural communities, although fur prices are very variable.

Problems with the current methods

- Possums that don't eat enough of the poison to be killed, only getting sick from it, can learn to avoid that kind of poison or bait in future.
- Many people, both in New Zealand and in the countries where we market our produce, are concerned about poisons being used for pest control, especially when spread from the air.
- With poisoning, other animals such as dogs, livestock, birds and insects are also at risk and may occasionally be killed.
- Trapping may also kill or injure other species, including endangered birds like the kiwi.
- Current methods require an ongoing commitment year by year.
- Possums are widespread throughout New Zealand, but control work often has to be focussed on the worst affected or highest priority areas. For example, the Department of Conservation spends $12 million each year but can only control possums on about one-sixth of the land it is responsible for.

For some years now science agencies have been looking into alternative methods of possum control. About $5 million a year is spent on researching biocontrols for possums; most of the research is being done by two Crown Research Institutes, AgResearch and Manaaki Whenua – Landcare Research. A national strategy committee was set up by government to coordinate possum control research. The committee feels that the current methods of possum control could in future be combined with new biocontrol methods for a cost-effective long-term solution to New Zealand's possum problem.

What is biocontrol?

Biocontrol is using biological means to control a pest, rather than chemical means (poisoning) or physical means (trapping, shooting, fences). Biocontrols often work with one organism to control another, using natural enemies of the target pest species, such as parasites, viruses or bacteria. Biocontrol organisms can also be modified to interfere with normal bodily processes within the target species.

There are two stages to any biocontrol process:

- the biocontrol itself, which has a direct effect on the possum, and
- the delivery system that will get the biocontrol into the possum.

Parasites and viruses

In New Zealand, possums have only a few parasites (such as intestinal worms), which in themselves have little effect on possum numbers. There are viruses which infect possums, including "Wobbly Possum Disease" which is fatal in captive animals. However little is known about these viruses, and more research work is needed to find out if they could be useful for possum control.

Possum viruses and parasites may also be genetically modified and used as a delivery system, to carry the biocontrol into the possums' bodies.

What is fertility control?

Fertility control is a particular kind of biocontrol which interferes with the breeding process or with the survival of young possums.

Research is currently under way on several possible methods, such as a way to interfere with possum hormones. A toxin or poison could be fed to possums which would affect only certain cells in the pituitary gland, which produces reproductive hormones. This would interfere with hormonal processes and make the possum permanently sterile.

Other possible fertility control methods involve genetic modification.

How does genetic modification work for possum biocontrol?

Genetic modification is changing an organism by changing its genetic patterns or DNA. This can involve transgenics – adding genes from one organism into another.

For possum biocontrol, the possum genes that control reproduction could be inserted into a parasite or a virus that only lives in possums. This genetically modified parasite or virus could then be spread into the possum population, disrupting their normal reproductive processes.

Instead of putting the genes that control possum fertility into a parasite or virus, they could be put into plants, so that the plants, as they grow, produce the possum biocontrol in their leaves, fruits and root systems. These transgenic plants could either be eaten directly by the possums, or harvested and processed to make a bait.

Immunosterilisation or immunocontraception

Using genetically modified biocontrols, possums could be "immunised" against specific proteins in their own reproductive systems. The possum's body would be tricked into producing an immune reaction to fight against its own reproductive proteins and destroy them, as if they were a disease. This would make the possum sterile.

How would it affect the possum?

- ***Interfering with fertilisation***
  Certain proteins have been identified that are essential for possum sperm to fertilise the egg. These proteins could be delivered to possums, using a genetically modified plant or virus. Fertilisation processes would be blocked, so the possums could not become pregnant.

- ***Interfering with the development of embryos***
  The proteins that control the growth of a possum embryo could be put into a bait through a transgenic plant process. When a possum eats the bait, its bodily systems would be altered so that no embryos are able to develop, and therefore no new possums are born.

- ***Preventing development of the sexual organs***
  When possums are born, their reproductive systems are just beginning to develop. Proteins involved in this development could be delivered into the female possum through a genetically modified virus or parasite. The biocontrol would then pass through the milk to the joey; this would stop its sexual organs developing and leave it sterile.

- ***Interfering with milk production***
  A biocontrol could be delivered to the female possum so that she does not produce milk at all, or so that important proteins are not produced in the milk. There would be no food for the joey.

Another way of affecting the survival of the joey could be to deliver a biocontrol to the female possum which would block the production of natural antibodies in the milk. The joey would then have no immunity against disease or other infection.

Possums are marsupials, and carry their young in a pouch on the belly. At birth, the young possum (or joey) is less than 1 cm long, blind and deaf. It has no immune system and can not regulate its body temperature. Many of its basic body systems are not yet developed. It has to stay inside the mother's pouch for 4 or 5 months before it is able to survive on its own.

How does the biocontrol get into the possum?

There are a range of different ways by which biocontrols could be spread through New Zealand's possums. Viruses or parasites that are naturally transmitted from possum to possum could be used to carry biocontrols.

Other delivery systems use methods where every possum must either eat the biocontrol or physically come into contact with it. These methods include:

- ***baits:*** dropping bait from the air or using bait stations on the ground, as is already being done with poison baits;
- ***aerosols:*** using a device that sprays the biocontrol in a fine mist onto the possum's face (this system is now being researched to deliver Tb vaccines to possums); and
- ***transgenic plants:*** genetically modified plants, which would produce the biocontrols in their leaves and fruit, could be made into baits or grown along the margins of forest or pasture areas, or around crops. Any suitable plant, including native species popular with possums, could be modified in this way; sterile plants could be used so they would not spread naturally.

Can we be sure only possums would be affected?

Biocontrol could be made specific only to possums, or used in ways that would minimise risk to people or to other animals, by:

- using organisms that infect only possums;
- using proteins from possums that are quite different from the proteins of other animals;
- using poisons or toxins that are much more effective in possums than in other animals; and
- delivering baits in ways that are designed to stop other animals taking the bait.

What kinds of questions are people asking?

Many concerns have been raised about possum biocontrol and about genetic modification generally. These include:

- Concerns about:
  - intervening in the natural order of things, at very fundamental levels, in ways that have never been done before and which may not be reversible;
  - disrupting tikanga and the natural relationships established by the atua Ranginui and Papatuanuku; and
  - transferring genetic material from one species to another, seen by some as a breach of tikanga Maori as it interferes with the whakapapa and mauri of those species.

- Uncertainty about potential effects – some of these concerns are based in the history of earlier introductions into New Zealand of foreign species that have since become pests:
  - unintended genetic changes or transfer to other species;
  - other possible effects on plants, wildlife and ecosystems;
  - effects on water and waterways;
  - effects on the cultural and spiritual dimensions of the environment;
  - cumulative effects and long-term effects; and
  - biosecurity risks to other countries (eg. possible effects on Australian wildlife).

- Ethical considerations:
  - animal welfare;
  - concerns about contraception;
  - implications of interfering with reproductive systems; and
  - interfering with milk production.

- Uncertainty about who will pay for possum biocontrols, and who will benefit.

- Concerns about how biocontrols might be developed and introduced – what processes will there be for:
  - consultation and providing information;
  - making decisions about research and release;
  - fitting in with local conditions and requirements;
  - working in with current control methods;
  - employment and training in local communities; and
  - handling, transport and disposal.

Appendix D

Possum Biocontrols - Technical Information

The Parliamentary Commissioner for the Environment is independent of government, advising on critical issues for New Zealand's environmental management. The Commissioner has begun a project to explore public attitudes to fertility-based biocontrol technology for possums. Biocontrol techniques have been identified as an important potential alternative for possum control. Scientists from New Zealand Pastoral Agriculture Research Ltd (AgResearch) and Manaaki Whenua – Landcare Research New Zealand Ltd (Landcare Research) are currently investigating these technologies. This paper follows on from the Commissioner's information pamphlet "Possum Biocontrols" giving technical information on the options being considered.

Introduction

Possums are New Zealand's Number One animal pest, causing millions of dollars' worth of damage to New Zealand's biodiversity, agriculture and forestry.

However, there are limitations to the effectiveness of current control methods for possums, principally poisoning and trapping. The use of poisons raises a number of problems and concerns. For some years now science agencies have been looking into alternative methods of possum control. About $5 million a year is spent on researching biocontrols for possums. Most of the research is being done by two Crown Research Institutes, AgResearch and Landcare Research. A national strategy committee was set up by government to coordinate possum control research. The committee feels that the current methods of possum control could in future be combined with new biocontrol methods for a cost-effective long-term solution to New Zealand's possum problem.

What are the potential biocontrol methods?

What is biocontrol?

Biocontrol is the use of biological means to control pests, rather than chemical means (poisoning) or physical means (trapping, shooting, fences). Biocontrols often work with one organism to control another, using natural enemies of the target pest species such as parasites, viruses, or bacteria, that either kill the pest or interfere with its breeding. Genetically modified examples of such organisms can also be used as vectors (carriers) for biocontrol agents to affect normal bodily processes (reproduction, growth or development) within the target species.

Biocontrol of possums

Pathogenic organisms: Parasites and viruses

Pathogenic organisms kill or debilitate the animal they infect. Parasites and viruses that will reduce possum numbers (the possum equivalents of diseases like myxomatosis or rabbit haemorrhagic disease) are being sought.

In New Zealand possums have a very limited range of parasites and it is apparent that these parasites have little effect on possum numbers. In their native Australia, possums have many more parasites; few of these are found only in possums, with the notable exception of a worm, *Adelonema trichosuri*.

A range of virus types, including herpesviruses, adenoviruses, coronaviruses, coronavirus-like particles and retroviruses have been identified in possums in New Zealand. Two viruses were found in captive colonies of possums including the virus "Wobbly Possum Disease", which is fatal for

found in captive colonies of possums including the virus "Wobbly Possum Disease", which is fatal for captive animals. However, little is known about these viruses and it is not known whether they are possum-specific. Much more work is required to determine if viruses could be useful for controlling possums in the wild.

Fertility control

Fertility control is a particular form of biocontrol which includes methods which would interfere with the breeding process and/or the survival of young.

The processes currently being investigated include:

Fertility control method	*What it interferes with*
Fertilisation	*the interaction between sperm and egg so that fertilisation is prevented.*
Development before birth (embryonic)	*the normal development of the embryo.*
Development after birth (post-natal)	*the development of reproductive organs or of the determination of sex.*
Hormonal control of reproduction	*the production or the action of hormones that affect breeding or sexual behaviour.*
Lactation	*milk production or the production of essential proteins in milk.*
Immunity provided by milk	*the transfer of antibodies from milk to pouch young (joey).*

Immune response method

Most of the methods being researched for biocontrol would involve interfering with fertilisation through immune response methods. This would work through the immunisation of possums against specific key proteins involved in reproduction. This is often referred to as immunocontraception or immunosterilisation. The concept is that immunised possums would be 'tricked' into producing antibodies against their own reproductive proteins, as they would against any foreign protein. This would block the action of the reproductive proteins, or result in their destruction.

Antibodies are chemicals that act against foreign proteins, disease organisms or against the toxins or poisonous wastes that disease organisms produce. Each antibody is very specific and once it has been made by the blood it will remain in the circulation for some time. This means that the body has become immune to the protein or disease organism, because the antibodies will attack them as soon as they enter the body.

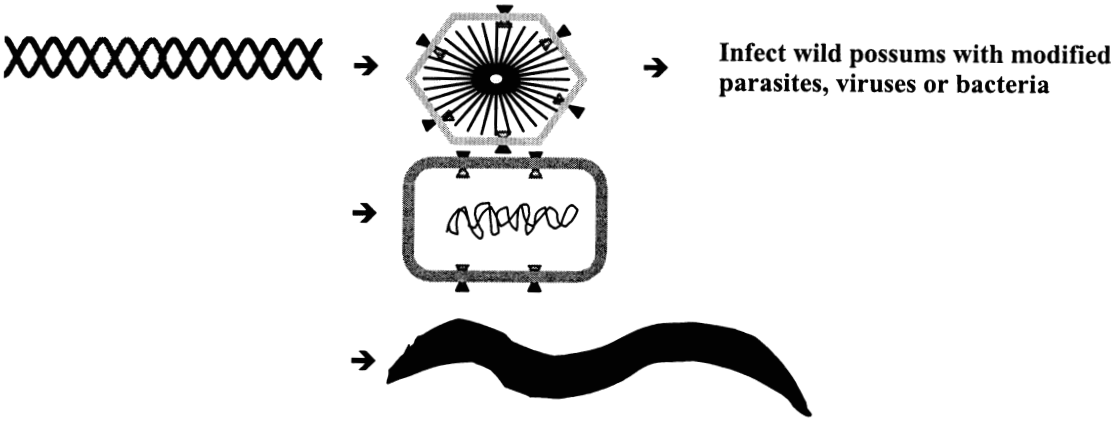
Examples:

Some possible examples of this approach and various delivery methods include:

1. Interfering with fertilisation – Method 1

For possum sperm to fertilise the egg it must first stick to a special coat that surrounds the egg. The proteins that make up the egg coat would be identified. The possum DNA sequences (genes) that make up the code for these proteins would be determined. These genes could then be inserted into a possum-specific parasite (i.e., intestinal worm), or a possum-specific virus. This genetically modified organism (vector) could then be used to infect wild possums. The infected possums would respond by producing antibodies against the egg coat proteins now being made by the genetically modified organism. These antibodies would end up in the reproductive tract where they would attach to the coat of the developing eggs rendering them impenetrable to sperm. No eggs could be fertilised.

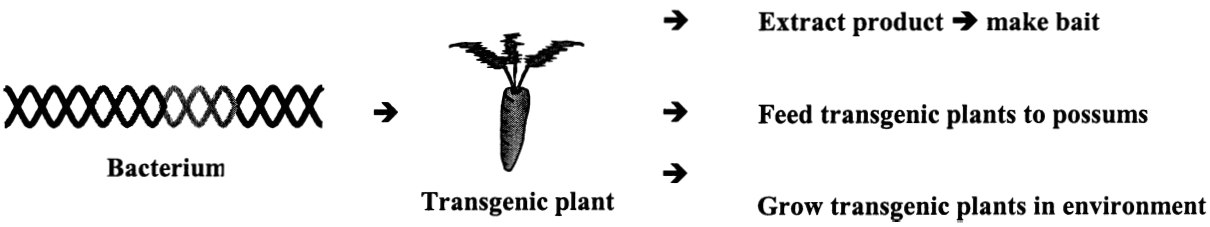
A possum gene is inserted into the DNA of a possum-specific virus, bacterium or parasite.



2. Interfering with fertilisation – Method 2

Instead of putting the genes for the possum egg coat proteins into a parasite or virus, they could be put into plants. With the inserted gene, the transgenic plants as they grow, would produce the possum proteins in their leaves, fruits and tubers. This material could be eaten directly by the possums or harvested and processed to produce bait. Once they had eaten the transgenic plants or baits, the possums would produce antibodies and the result would be as described in Method 1 above.

A possum gene plus a bacterial gene is inserted into the DNA of a plant (the bacterial product is necessary to protect the possum protein from the gut environment once it has been eaten and to enhance the immune response later in the possum).

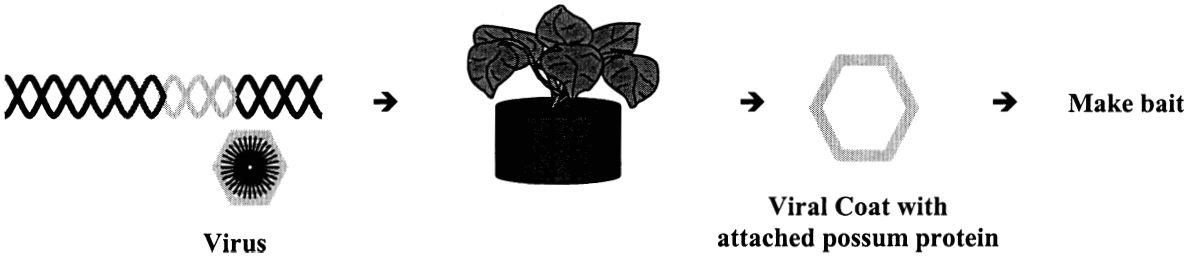


3. Preventing development of embryos

A protein important for the development of the possum embryo would be identified. The gene that makes up the code for the protein would be determined; the gene that makes up the code for the protective coat which surrounds certain viruses would also be determined. The possum and virus genes could then be combined and put into a plant. The transgenic plant would then produce the viral coat protein (virus-like particles) with the possum protein as part of it.

This new product could then be extracted and purified from the plant and put into bait. When a possum would eat the bait, antibodies would be made to the virus coat protein and also to the possum protein because it would now be part of the viral coat. Thus, the possum would be tricked into making antibodies against one of its own proteins. These antibodies would prevent the development of the embryo and no offspring would be born.

A possum gene is added to a viral gene and this is then inserted into the DNA of a plant.



4. Preventing Development of the Reproductive System

When possums are born, their reproductive system is just beginning to develop. A protein necessary for the development of the reproductive system would be determined and the procedure outlined in Method 1 could be followed. The antibodies produced in this case would then be transferred from the adult female possum through the milk to the developing joey. The antibodies would prevent development of the reproductive system, leaving the joey sterile.

5. Interfering with lactation

A biocontrol organism could be delivered to the female possum so that she does not produce milk at all, or so that important proteins are not produced in the milk. There would be no food for the joey in the pouch.

Another way of affecting the survival of the joey could be to deliver a biocontrol organism to the female possum which would block the production of natural antibodies in the milk. The joey would then have no immunity against disease or other infection for the first three months until its own immune system developed.

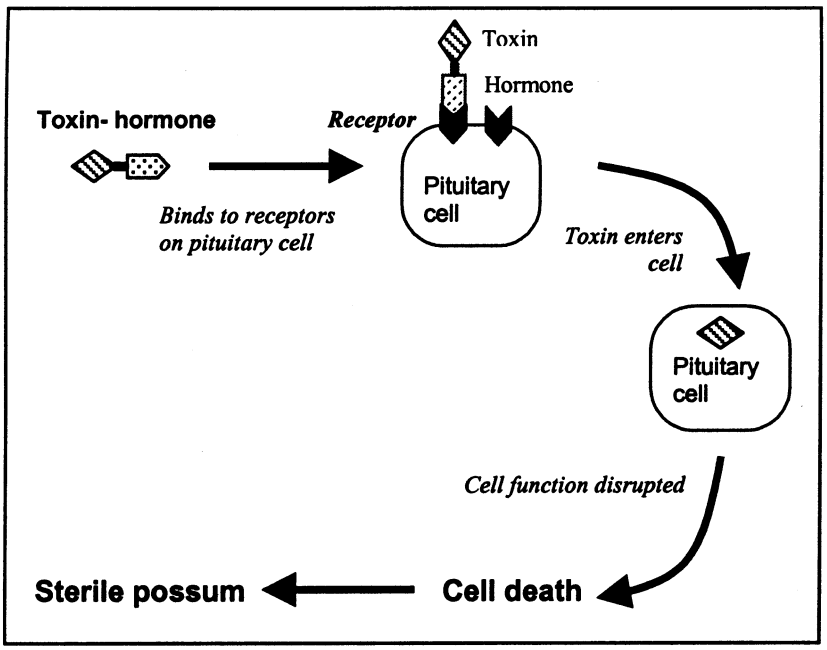
'Non-immune' methods

Methods which do not rely upon evoking an immune response could also be effective for fertility control. One example could be to work with biologically active peptides or proteins which might be used to deliver toxins specifically to certain types of cells.

Example: Interfering with reproductive hormones

Researchers are testing the possible use of plant-derived toxins which could be attached to a hormone which will only bind to the cells in the pituitary gland which produce reproductive hormones.

Once bound, the hormone-toxin conjugate would be taken into the cell where the toxin would be released resulting in the death of that cell. This would result in either male or female possums becoming permanently sterile from a single dose.



Delivery systems

There are two stages to any biocontrol process:

- developing a method of biocontrol, which has a direct effect on the possum, and
- a delivery system, which would transmit the biocontrol agents and organisms to New Zealand's possum populations.

Non-transmissible systems

Every individual possum must either ingest or physically come into contact with one of these systems.

- ***Bait delivery***
  Aerial baiting could deliver baits routinely to more than 90% of possums. Bait stations could also be used.

- ***Aerosol delivery***
  It may be possible to sterilise possums by using a device that sprays the vaccine as a fine mist onto the possum's face. Such a system is now under development for delivery of Tb (Bovine tuberculosis) vaccines to possums.

- ***Direct use of transgenic plants***
  Genetically modified plants, which would produce the immunising protein as part of their leaves and/or fruits (transgenic plants), could be grown along forest/pasture margins or around crops. Possums would feed naturally on these palatable plants and be sterilised. In theory, any suitable plant, including native species, could be modified in this way but there would be advantages in using sterile plants so that they could not spread naturally.

Transmissible (naturally spreading) system:

A biocontrol organism that would spread naturally from possum to possum (for example, an organism passed during mating) could be used. Such a delivery system would require a suitable possum-specific organism (vector) that is:

- capable of infecting a large proportion of the possum population;

- able to be genetically modified to include the genes for the possum proteins;
- able to produce the possum proteins to a sufficient extent in the possum.

Existing possum viruses or parasites may be able to be modified for this purpose. Research is currently focussed on developing genetically modified forms of the possum-specific gut worm *Parastrongyloides trichosuri* and a recently-discovered possum-specific adenovirus.

Making biocontrol specific for possums

Biocontrol can be made specific to possums or used in ways that minimise the risks to other animals by:

- using vectors that infect only possums;
- using immunising proteins from possums that are quite different from those of other animals;
- using toxins that are much more effective in possums than in other species;
- delivering baits in bait stations designed to minimise access by other animals.

GLOSSARY

Antibody – a protein produced by the immune system to attack 'foreign' material, such as dead or diseased cells, other proteins, or disease organisms like viruses and bacteria.

DNA – Deoxyribose nucleic acid. The chemical which makes up the genetic code (genes).

Fertilisation – the process by which the sperm joins to the egg and forms a new individual (embryo).

Gene – a 'blueprint' that contains all the instructions to tell a cell how to manufacture a particular protein. Each gene contains the instructions for a unique protein.

Genetic engineering – modification of the genes within an animal or plant, either by adding or removing genes, which may come from different species or which may have been modified.

Hormones – proteins produced by one type of cell that affect another type of cell, usually stimulating them to produce other proteins. Sex hormones are essential for mating behaviour and breeding.

Immune system – a complex set of defence mechanisms designed to protect the body from foreign organisms, toxins, and diseased and dead cells.

Immunisation – the process of activating the immune system.

Lactation – the period during which a female mammal feed her young with milk.

Parasite – an organism that lives in or on another organism and obtains its food from it.

Pathogen – disease causing organism.

Physiological processes – the processes that go on within an animal or plant that support all aspects of its life e.g., reproduction, growth, development, metabolism.

Proteins – essential parts of all cells. Some make up cell structures, others act as messengers or regulating factors.

Receptor – a structure on the surface of cells to which a protein can attach. This usually results in the protein being taken into the cell.

Vector a species-specific organism, like a virus, that will spread naturally, for instance from possum to possum.

FURTHER READING

If you are interested in further information about possum biocontrol and biocontrol issues generally, you can get further information from the following sources. These reports are available from their publishers or through public libraries.

Fitzgerald, G.P., Wilkinson, R.L. 1996. Public Perceptions and Issues in the Present and Future Management of Possums. *MAF Technical Paper 96/4.* Wellington: Ministry of Agriculture.

Hackwell, Kevin, and Bertram, Geoff. 1999. *Pests and Weeds: The cost of restoring an indigenous dawn chorus: A blueprint for action against the impacts of introduced pest organisms on the New Zealand environment.* Wellington: New Zealand Conservation Authority.

Jarvis, B.D. (comp.) 1999. Rabbit control, RCD: Dilemmas and Implications. *Royal Society of New Zealand Miscellaneous Series No. 55.* Wellington: New Zealand Association of Scientists supported by the Royal Society of New Zealand.

National Science Strategy Committee for Possum & Bovine Tb Control 1998. *Annual Report 1998.* Wellington: Ministry of Research, Science and Technology.

Parkes, J., Baker, A.N., Ericksen, K. 1997. *Possum Control by the Department of Conservation.* Wellington: Department of Conservation.

Parliamentary Commissioner for the Environment 1998. *Possum Management in New Zealand: Critical Issues in 1998.* Wellington: Office of the Parliamentary Commissioner for the Environment.

Parliamentary Commissioner for the Environment 1998. *The Rabbit Calicivirus Disease (RCD) Saga: a biosecurity/bio-control fiasco*. Wellington: Office of the Parliamentary Commissioner for the Environment.

Sutherland, G. (ed.) 1999. Advances in the biological control of possums. Report of a workshop sponsored by the National Science Strategy Committee for Possum & Bovine Tb Control. *Royal Society of New Zealand Miscellaneous Series No. 56*. Wellington: Royal Society of New Zealand. (This is a detailed technical report containing scientific papers by almost all possum biocontrol researchers in New Zealand and Australia. It provides a summary of all facets of current research into possum biocontrol.)

Wilkinson, R.L., Fitzgerald, G.P. 1998. Public Attitudes to Rabbit Calicivirus Diesase in New Zealand. *Landcare Research Science Series Report No. 20.* Lincoln: Manaaki Whenua Press.

Appendix E

List of People Consulted

AgResearch Ruakura: Terry Parminter, Liz Wedderburn

AgResearch Wallaceville: Mark Ralston

Animal Health Board: Nick Hancox, Victoria Anderson

Crop and Food Research: Mike Dunbier

Dairy Board: Kevin Marshall, Lindsay Burton

Department of Conservation: Grant Baker, Andrew Bignell, Herb Christophers, John Cumberpatch, Alan Edmonds, Sean Goddard, Ned Hardie-Boys, Geoff Hicks, Katie Mathison, Clare Miller, John Ombler, Nicola Patrick

ECO: Cath Wallace

Environmental Risk Management Authority: Stephen Thornton, Donald Hannah, Elizabeth Beale, Bevan Tipene Matua

Environment Southland: Mark Hunter

Federated Farmers: Catherine Petrie

Forest and Bird: Kevin Smith

Foundation for Research, Science and Technology: Marie Bradley, Jenny Steven

Gray Fur, Hokitika: Peter Gray

Independent Biotechnology Advisory Council: Peter Gluckman, Steve Goldson

Ministry of Agriculture and Forestry: Peter Kettle, Barry O'Neill

Ministry for the Environment: Owen Cox, Ginny McLean, Terry Smith, Kataraina Maki

Ministry of Health: Sally Gilbert

Monsanto: Murray Willocks, Brian Arnst

Muaupoko: Vivienne Taueki

New Zealand Conservation Authority: all members

New Zealand Insurance Council: John Lucas, Chris Ryan

New Zealand Life Sciences Network: Francis Wevers

Nga Kaihautu Tikanga Taiao: Gerard Albert, Leatrice Welsh, Mere Roberts, John Hohapata-Oke, Murray Parsons, Makere Forster

Ngai Tahu: Edward Ellison

Ngatihine: Kevin Prime

Ngati Raukawa: Rupene Waaka

Ngati Wai: Hori Parata

SAFE (Save Animals From Exploitation): Gary Reece

Southland District Council: Andy Crichton

Te Kotahitanga o Te Taitokerau: Leatrice Welsh, Cyril Chapman (Radio Tautoko, Okaihau) and Taitokerau iwi representatives

Te Kotuku Whenua, Ngati Wairere: Jacqui Amohanga, Angeline Greensill, Malibu Hamilton

Te Puni Kokiri: Aroha Mead, Georgina Roberts, Teneti Ririnui

Te Tau Ihu o Te Waka: iwi representatives from Ngati Koata, Ngati Rarua, Ngati Tama and Te Ati Awa, in consultation process with AgResearch

Unilever (UK): Prof. Jim Leslie

University of Otago: Hugh Campbell

WAI 262 claimants: Hana Waitai Murray (Ngati Kuri) and Del Wihongi (Te Rarawa) (Murihiku Marae, August 2000)

Wellington Regional Council: Wayne O'Donnell, Ray Clarey

Wellington Society for the Prevention of Cruelty to Animals: Rosemary Williams