THE CURRENT STATE OF RABBIT MANAGEMENT IN NEW ZEALAND

Issues, options and recommendations for the future

Contract report for MAF Biosecurity New Zealand

October 2009

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Acknowledgements

The preparation of this report has involved the assistance of many with knowledge of land management, particularly in relation to the rabbit pest - landholders, regional authorities, government departments and science organisations. Some have gone to considerable trouble to provide information at very short notice; others have contributed significant time to meetings and telephone discussions.

Particular mention must be made of Professor Paul Atkinson of Victoria University of Wellington for the significant time he put aside to advise on research into rabbit haemorrhagic disease. Special acknowledgement is due for the major involvement of Don Robson in applying his long experience and expertise in pest management to the content and analysis in this report.

Terms of reference

This report was commissioned by MAF Biosecurity New Zealand in August/September 2009 with the following requirements:

a. Collect and collate information on rabbit population trends pre and post rabbit haemorrhagic disease (RHD), and make predictions on future trends;

b. Identify examples of land management and pest control methods (and the associated costs) that have maintained the benefits of RHD on rabbit prone land and how this can be used to inform best practice;

c. Establish the extent of environmental impacts by rabbits and how that compares to economic and other impacts;

d. Examine the case for further public funding of rabbit control to support environmental outcomes;

e. Identify any research needed to address knowledge gaps in assessing rabbit impacts or for future rabbit management;

f. Establish the current management and funding arrangements being used in rabbit management, including identifying the cost of ratepayer funded council monitoring programmes;

g. Examine the Federated Farmers proposal to establish independent Rabbit Control Boards (or other possible models) for distribution of potential future funding;

h. Identify mechanisms to support collective action (groups of land occupiers working together) including the roles of agencies and land occupiers;

i. Consider any wider linkages, such as the High Country tenure review process, other high country pest management issues, and alternative approaches to sustainable land management practices on rabbit prone land.

MAF Biosecurity New Zealand directed that the focus of the report should be on the rabbit prone regions of the South Island.

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1. Executive summary

MAF Biosecurity New Zealand (MAFBNZ) commissioned this report in August 2009. It is intended to inform and guide improvements to rabbit management. Its findings and recommendations will next be tested within a review of the pest management system that is already underway (the 'Future of Pest Management' project). In part, it was also prompted by a request from Federated Farmers of New Zealand for public funding of rabbit control on private land.

Evidence and comment provided by regional councils, government departments, farmers, scientists and pest management experts, together with published and unpublished information, have contributed to the observations and conclusions of this report.

1.1. *The impacts of rabbits*

Rabbits pose a significant threat to production values – they compete with livestock for grazing and provide a staple diet for vectors of bovine tuberculosis. Along with farmed livestock, particularly sheep, they have modified vegetation cover and composition. At higher numbers they can cause significant soil damage and soil erosion, with subsequent effects on water values. The costs incurred in their control can be very high and, where toxins are used, there can be major disruption to grazing management because of the need to keep the land clear of livestock.

Together with farmed livestock, rabbits also damage natural ecosystems, plant communities with specific conservation values, threatened species and their habitats. Rabbits can also pose indirect risks to valued fauna by supporting resident populations of predators such as ferrets and cats. One hundred and fifty years of pastoral farming and repeated 'explosions' in rabbit populations have modified the original vegetation to the extent that, in large areas of the semi-arid lands, the most extensive environmental threat posed by rabbits is to the soil. By the time significant soil erosion occurs productive values will largely have been lost.

Several major reviews have concluded that the interactions between farmed livestock and rabbits confound the differentiation of their relative effects on productive and environmental values. Nevertheless, there is no question that the effective management of rabbits is of the utmost importance in protecting these values.

1.2. *Population trends*

New Zealand has a long history of rabbit management, including periods of substantial public investment. In more recent history (1980's) the pest destruction boards, heavily funded by the taxpayer, struggled to cope with the change to a user-pays approach to pest control. The effectiveness of this transition may have been hampered by an established mindset that the total responsibility for killing rabbits lay with the boards. Rabbit populations began to increase.

The most recent period of intense Government intervention ensued in 1989 by way of the Rabbit and Land Management Programme. Rabbit numbers rose again as the programme ended and continued to rise until the illegal introduction of rabbit haemorrhagic disease virus in 1997.

Rabbit haemorrhagic disease (RHD) devastated rabbit populations and rabbit control came to an end on many properties. Landholders were urged to take full advantage of RHD by targeting survivors with conventional secondary control methods. RHD is still effective and making a difference, but secondary control measures will always be needed on the most rabbit prone lands and there are many examples where they have been applied to good effect.

There are also properties on which there has been little rabbit control work since 1997 or where the control effort has increased but the measures applied have been unsuccessful in suppressing rabbit numbers; the level or work may have been inadequate or miss-matched to the level of rabbit infestation. In many cases, rabbit populations have increased to levels that require costly poisoning programmes to regain control; this has not been easy for landholders.

… the problem is confined to the semi-arid lands of the South Island; elsewhere populations have been generally low and stable.

Regional pest management strategies are helping to limit the occurrence of unacceptable population increases and the councils have confidence in their regulatory measures. However without ongoing and well-executed secondary control, more landholders will find that their rabbit populations increase to levels requiring large scale poisoning.

1.3. *Spotlight on effective rabbit management*

The principal factors attributed to maintaining low to moderate rabbit levels are the successful use of secondary control measures by some landholders, RHD and the various agents that cause natural mortality in rabbit populations.

Common factors among landholders who have maintained low rabbit populations since the arrival of RHD, often on land of extreme rabbit proneness, are:

- They accept full management and financial responsibility for rabbits
- They are well-informed and plan ahead
- Rabbit management is an integral part of the business as a whole
- There is an annual financial commitment to secondary control
- They are vigilant
- They use skilled and committed staff
- They use control methods appropriate for the terrain and rabbit population densities

The main secondary control measures used are night-shooting, day shooting with dogs, fumigation of rabbit burrows, helicopter-shooting and small areas of patch poisoning. Shooting is the predominant method. Rabbit control costs provided by several landholders have ranged from less than $1.50 to as much as $7.00 per stock unit.

While ongoing success cannot be guaranteed, these farmers have demonstrated that long-term suppression of rabbit populations on high and extreme rabbit prone land is achievable in the post-RHD environment.

Epidemiological predictions for RHD cannot be reliable and a conservative approach is advisable in the rabbit prone regions; the survivors of RHD should be targeted for control.

While every effort should be made to reduce reliance on major poison programmes, they remain the only realistic backstop for regaining control of burgeoning rabbit populations beyond the reach of other control measures. It is concerning to find evidence of poorly conducted primary poison operations that have resulted in failure. The financial consequences can be severe for landholders. Of greater concern is the potential resurgence of the major bait and poison shyness problems that arose from poor practice during the final years of the pest boards in the 1980s.

Recommendation 1

Councils must act with some urgency to seek regulations, standards or mandatory codes of practice for poisoning programmes to ensure that future rabbit management is not compromised.

1.4. *Research considerations*

1.4.1. Asking the right questions, finding the right answers

Quality research is still important …

'Effective quality research on questions of sustainability requires an informed, coordinated, collaborative, inter-disciplinary approach with top research capability. Research methodologies need careful selection and the appropriate streams of research endeavour and skill must be logically and coherently planned and then executed in a manner which will give both certainty and relevance to the conclusions.'

(Working Party for sustainable land management,1994).

1.4.2. Immunity

There is some uncertainty over whether the cELISA enables an accurate assessment of a rabbit population's level of immunity; it would be in the interests of rabbit management to improve it.

Recommendation 2

Investigation by the Wallaceville Investigation and Diagnostic Centre to better determine the need and potential for refining the cELISA assay.

1.4.3. Genetic resistance

Recent international research suggests that the virus could be selecting a rabbit blood group sub-population for survival that is unable to be infected owing to the lack of the correct blood group viral receptor. This means that a proportion of surviving rabbits may not be immune at all but rather a genetically resistant selected sub-population unable to get the disease. Unlike immunity, genetic resistance is a heritable characteristic and so, without secondary intervention, it could be expressed in a growing proportion of the total rabbit population. The selection pressure in confined populations may be higher.

Recommendation 3 – to MAF

An investigation led by a populations geneticist to determine the presence of genetic resistance in feral rabbits and to consider the implications for management.

1.4.4. Encouraging effective rabbit management

Landholders on some of the most rabbit prone land in New Zealand have demonstrated that effective control is achievable in the post-RHD environment. Social science research can improve understanding of how to ensure wider adoption of effective approaches to control

Recommendation 4

A review initiated by the Rabbit Coordination Group into how to ensure the adoption of successful approaches to rabbit management in the rabbit prone semi-arid lands.

1.4.5. Reliance on toxins

Heavy reliance on the toxin 1080 and, to an increasing extent, pindone as the primary tools for regaining control of rabbit populations remains a weakness in rabbit management. Social, technical, financial and trade limitations may well restrict their use in the future.

Recommendation 5 – to public good research funders

The search for acceptable alternative toxins and for more cost-effective approaches to their use in rabbit control should continue as a priority.

1.4.6. Creating more resilient ecosystems

Where market rationalisation fails to deal adequately with unproductive areas of the most highly rabbit prone land, the option of encouraging their transformation into new and more resilient ecosystems arises.

Recommendation 6 – to funders of public good research

A review of effective methods to transform highly rabbit prone lands to more resilient ecosystems.

Functional benefits should also be considered such as habitat for native fauna, seed sources for natural spread of underrepresented species, native wildlife corridors and carbon sequestration. Any such review should highlight aspects requiring research, such as seed ecology of woody species.

1.5. *Rationalisation by market forces*

A change in land use and/or the balance of land types within a property enables a re-evaluation of how to manage the threats posed by rabbits. Market forces have been working to re-shape land uses and to rationalise property boundaries within or between land uses. These changes have resulted in some enterprises more capable of sustaining effective rabbit management. The review of pastoral lease tenure has played a part in this process.

… there is still scope for further rationalisation of boundaries and enterprises to enhance the potential for effective rabbit management.

1.6. *Is there a case for Government intervention?*

1.6.1. Public good funding

Research

The rationale for public good funding of research is well established, either through the Foundation for Research Science and Technology or through operational research funding by central and local government agencies. The market alone is unlikely to generate the necessary resources to fund ongoing research into rabbit management or to ensure that the results are fully disseminated to land owners in the affected areas

A predicted skills shortage

The amount of professional expertise and experience in rabbit control has diminished and now lies largely within the councils. There is a looming shortage of capable, experienced and qualified pest workers for the increased effort into rabbit control that is clearly necessary. Farmers and councils have raised this as a significant concern. In many cases, landholders themselves lack the skills to train such people.

Training and employment is not solely a benefit for rabbit management - those involved will be able to apply their skills to a range of pests. It takes time to build a skilled work force and the need for increased effort in rabbit control creates an urgency that may not be adequately met by normal market forces.

Recommendation 7

Regional or central government initiatives to address the looming skills shortage for rabbit management.

Supporting collective action

For landholders, community approaches offer many advantages in pest control, especially in coordinated cross-boundary approaches, access to technical assistance and information, and economies of scale. Central and local government agencies can often provide information, training and technical assistance in a more efficient, effective and more integrated way to groups of landholders.

Recommendation 8

Central and regional government agencies must be ready to respond with information, training and technical assistance where landholders initiate collective approaches to rabbit management.

Councils can and do offer support to community groups and can improve a group's effectiveness by reducing the administrative burden normally shouldered by one or two individuals. There is potential however for collective approaches to lead to a loss of individual responsibility and less 'ownership' of the rabbit problem; groups are more likely to endure as successful managers of rabbits when the motivation comes from within.

Recommendation 9

Council pest management staff at the interface with landholders should be given the support, technical information and professional development required to enable them to help fulfil their roles.

Where landholders face difficulty with rabbit control, the goal should be to work positively with them in planning the best approach and in determining roles, responsibilities and timeframes for action. In this respect, consideration should be given to avoiding any potential conflict with enforcement roles.

Recommendation 10 – to MAF

Subject to any decision on public funding for rabbit control, an investigation may be warranted into whether the Rabbit and Land Management Programme Property Plans were effective mechanisms for 'locking in' the benefits derived from public funds.

Providing information

There is a need to improve the availability of authoritative, practical and scientific advice on RHD.

Recommendation 11 – to MAF and Regional Councils

Consideration should be given to the creation of a small specialist capability, operating from a broader land management perspective but knowledgeable on RHD and rabbit management, whose role is to promote best practice in all aspects of rabbit management, provide training and well-supported technical information and play a key role in guiding research.

Recommendation 12 – to MAF and Regional Councils

The 'Rabbit Fact Pack' information resource should now be updated with current information on RHD reviewed by experts able to comment authoritatively on the disease.

Recommendation 13

Better use could be made of some Council websites to provide comprehensive information about RHD.

Recommendation 14 – to Regional Councils and Federated Farmers of New Zealand

Regular field days would allow a 'hands on' exchange between landholders and enable them to keep up to date with best practice in rabbit management in the post-RHD environment.

Recommendation 15 – to MAF

There may also be a case for reviewing the effectiveness of the land condition monitoring initiated by the Rabbit and Land Management Programme.

1.6.2. Funding of rabbit control on private land

The Working Party on Sustainable Land Management (1994) concluded that public funding of resource management on 'private lands' could only be justified when all three of the following conditions prevailed:

- *'There are public benefits, associated with the land, which are not captured (or able to be captured) by the private land owner (a situation of public goods and externalities and hence market failure).*
- *The market process is prevented from finding the best land-uses, or supplying the sizes of enterprises best able, to maintain the condition of land resources in the long-term (a situation of market imperfection caused by the pastoral leasehold tenure and the Land Act 1948).*
- *The current land-use is unable to meet the full requirements of land conservation and is therefore putting the public interest at risk. '*

The evidence indicates that many landholders on land of high to extreme rabbit proneness are meeting their responsibility to control rabbits in the post-RHD setting, protecting production and environmental values.

Farmers are able to capture some of the 'public benefit' arising from the protection of the land resources of their properties from the threats posed by rabbits, including environmental resources.

Market forces have been working to rationalise land use, property size and land values to better enable the resulting enterprises to meet the requirements of rabbit management.

Current land uses have been able to contribute to land conservation, especially on those properties maintaining effective control of rabbits.

The three pre-conditions given above for public funding for resource management on private land do not prevail.

The benefits arising from the introduction of the biocontrol RHD have also diminished the core arguments of 'compensation for no biocontrol' and 'resource conservation' put forward in justification for the Rabbit and Land Management Programme.

Taken as a whole, the evidence presented in this report does not provide strong support to a case for the taxpayer to fund rabbit control on private land, even though some farmers are faced with costly programmes to counter increasing rabbit numbers. However, if it were to be decided to provide such funding, then it should be expected to be for the long haul. The following matters should also be taken into account:

- There should be clarity as to whether such taxpayer funds were intended solely to protect environmental values or to also protect the financial viability of rabbit prone properties.
- Committing public funds to primary poisoning programmes alone will require an acceptance that the allocation cannot be equitable between landholders.
- It is beyond the scope of this report to assess whether central government could lawfully fund rabbit control programmes on private land without a National Pest Management Strategy. Nor has it been determined whether central government funds could be directed to rabbit control through Councils whose Regional Pest Management Strategies require occupiers to meet the full cost of control.
- Government intervention could interfere with market driven rationalisation towards enterprises and structures better suited to rabbit management.
- Direct funding for primary poisoning could act as a disincentive to adequate secondary control and reduce the ongoing effectiveness of RHD.
- There should be an expectation from recipients that they will then engage in rabbit management approaches known to be effective.

1.6.3. Pastoral leases – a special case?

Many properties in the rabbit-prone semi-arid lands have pastoral lease tenure. If public funding were to be provided for rabbit control, could LINZ provide a conduit for allocating funds to leasehold land and play an active role in helping to ensure a lasting benefit from the investment? Would direct public funding for rabbit control, after deduction of rent, result in a net annual payment from taxpayers to lessees to occupy a pastoral lease in a 'caretaker' role?

Although the Biosecurity Act 1993 appears to be given precedence over the terms of pastoral leases in relation to rabbit control, should the Commissioner of Crown Lands take a greater interest when leaseholders have difficulty meeting the requirements of Regional Pest Management Strategies? What interaction takes place between the Commissioner, lessees and the councils?

Recommendation 16

The Commissioner of Crown Lands should investigate the need to take a more engaged and active approach to rabbit management on pastoral leases and confirm his position to lessees and councils.

1.6.4. Mechanisms for delivering effective rabbit and land management

Irrespective of who pays for future rabbit and land management, it is important to ensure value for money. This report examines a number of possible collective options, including the model put forward by Federated Farmers for the formation of local 'boards' working to geographic boundaries. Of these, Maniototo Pest Management Ltd (MPM), a company established by landholders in the Maniototo Basin, may provide a suitable model. Costs appear to be allocated more equitably in this model, it is not heavily reliant on the work of volunteers and an organisation such as this could readily be subject to external technical and financial audit. It should be noted that MPM operates very successfully in the Maniototo without any taxpayer funding for rabbit control on private land, however the model provides a clear opportunity for productive relationships with councils in relation to information exchange, training and best practice.

It has been demonstrated that effective long-term suppression of rabbit populations on high and extreme rabbit prone land is achievable in the post-RHD environment. Effective use of secondary control measures, RHD and sound land management practices are key to successful rabbit management. The current user-pays system still serves us, and the case for public funding appears weak; landowners need to take responsibility for rabbit management. However, there is a strong case for and opportunity to strengthen Government intervention to support collective action and improve access to specialist information, research, advice and skills.

2. Introduction

It has been twelve years since rabbit haemorrhagic disease decimated yet another rising rabbit population in the most rabbit prone parts of the South Island and rapidly spread throughout the country. For a time, it seemed to good to be true – the land responded and the pest appeared to be generally subdued; but it was not to last. Over recent years, rabbit numbers have been rising again and it is time to draw on the knowledge and experience available, especially from farmers successfully managing the pest, to enable others to maintain control. The difficulty faced by some landholders prompted a proposal to central government from Federated Farmers of New Zealand in March 2009, for renewed public funding of rabbit control.

The terms of reference for this report were very broad and the window of time available very narrow, so the content, observations and conclusions have relied on existing knowledge and experience and information provided by councils, government departments, farmers, scientists and pest management experts as well as published and unpublished reports and research papers.

Although the brief is wide, it is focused narrowly on the management of one pest – the rabbit – and this is a potential weakness. It is important to be aware of interconnections between rabbits and other elements of the ecosystems in which they live, such as livestock and the rabbit predators that carry bovine tuberculosis.

The recommendations given are primarily aimed at encouraging the adoption of successful approaches to rabbit management, providing information, gaining more understanding about rabbit haemorrhagic disease and diagnostic work, dealing with a potential shortage of skilled pest staff and ensuring that future rabbit management is not compromised by inadequate technical standards. Further recommendations relate to funding and to securing any public investment in environmental protection on private land.

3. Background

The European rabbit (*Oryctolagus cuniculus*) was introduced into New Zealand in the mid 1800s, spread rapidly and soon began to seriously affect agriculture and natural ecosystems; it was quickly realised that rabbits had become a pest animal.

Mustelids and cats were brought in to contain the increasing populations but had little impact. Poisoning, trapping and shooting were widely used to attempt to control the rabbit pest but it was not until the de-commercialisation of rabbit carcases, and the establishment of rabbit boards in 1947, that effective rabbit control was achieved. This intensification of control, particularly the use of aerial applications of sodium monofluroacetate (1080) from 1953, together with extensive land development, saw a rapid and large reduction in rabbit numbers throughout NZ. This early success gave control authorities the belief that eradication of the rabbit was possible. Intensive secondary control, mainly in the form of night-shooting, was used throughout NZ with this goal. An attempt to establish myxomatosis in the early 1950's was unsuccessful due to the absence of a suitable vector.

By the 1960's, scientists were questioning the practicality of the eradication policy and the need for such costly approaches over much of New Zealand. A policy of 'control' was then introduced and efforts towards the control of rabbits became focused on the semi-arid lands of the South Island. Here rabbits remained a major problem and this was

putting a heavy financial burden on landholders, despite very significant Government financial assistance (up to 80% of control costs). Financial reform coincided with structural reorganisation. The dollar-for-dollar rates subsidy on pest destruction work was replaced in 1981 with a block grant and in 1984 the Labour government accepted the proposal in the James Report to progressively introduce a user pays approach to pest destruction - over a ten year period. As part of this policy, the $7 million block grant was to be progressively reduced by $0.8 million per annum (Trost, pers. comm.).

By the 1980s, much of the land was being poisoned regularly but this approach encouraged the development of bait avoidance (neophobia) and poison shyness; kill rates dropped well below those achieved in the early days of 1080 use.

In 1985, an application to the Government for the re-introduction of myxomatosis was declined. However, recognising that rabbits were a serious problem in semi-arid areas, the Parliamentary Commissioner for the Environment recommended the establishment of a Task Force in 1987 to address the problem through the development of integrated land management strategies. In 1988 the Ministers of Agriculture and Environment commissioned the Rabbit and Land Management Task Force to develop an integrated land management strategy. In September 1988 The Task Force recommended:

- that the Government continue to invest in rabbit management, primarily for resource conservation, but also as partial compensation for the denial of myxomatosis;
- that this investment be concentrated on the approximately 280,000 ha of highly rabbit prone land in the dry tussock grasslands;
- that the cornerstone of future rabbit and land management in the semi-arid regions should be a property plan;
- that research on the interactions between land type, land use and natural rabbit control agents (biological controls), particularly predators, must be intensified; and
- that funding for the programme be via local government under new contractual arrangements.

These recommendations formed the basis of the Rabbit and Land Management Programme (RLMP) that became operational with the establishment of regional councils in November 1989. The overall goal of the RLMP was to improve the long-term sustainability of land resources and ultimately of rural communities in rabbit prone areas.

Operationally, it consisted of:

- a grant (for rabbit control, fencing and habitat modification);
- a property planning programme, managed by regional councils; and
- a research, monitoring and facilitation/information exchange programme, managed by MAF.

The whole programme was guided by an advisory committee whose members were drawn from all key stakeholder groups. This committee was responsible for developing all programme policy. The $28 million programme ran from 1989 to 1995 with funding from central government, local authorities (regional councils) and participating landholders.

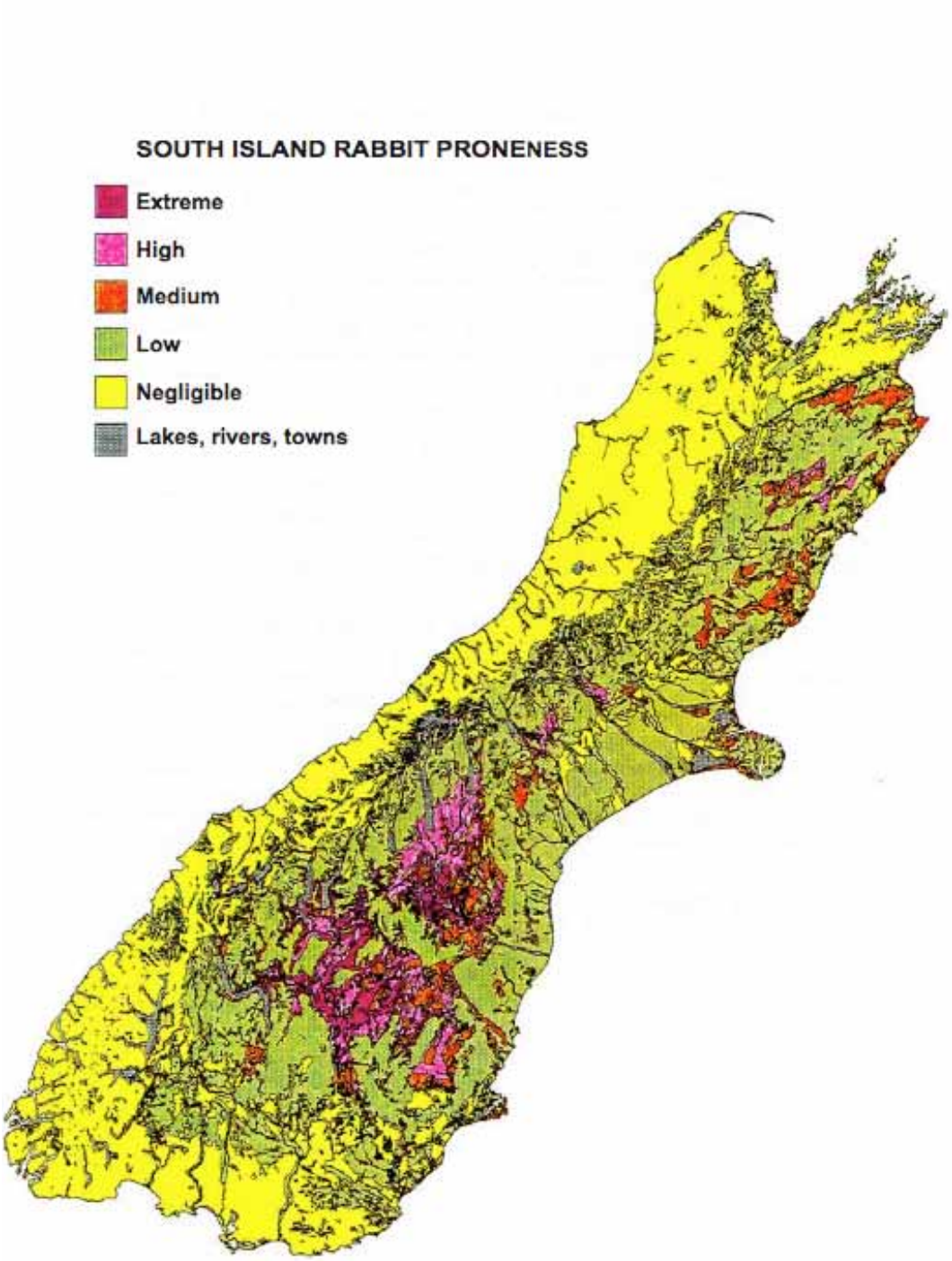


Figure 1: Rabbit proneness in the South Island (Source: RCD Applicant Group, 1996)

Table 1: Distribution of rabbit prone land in NZ

(source: RCD Applicant Group, 1996)

	Area (hectares)	
Proneness class	**North Island**	**South Island**
Extreme	–	376,559
High	–	628,536
Medium	607,347	819,291
Low	3,347,889	5,972,487
Negligible	7,217,064	6,675,432

The 115 properties that participated in the RLMP were selected according to their rabbit proneness and comprised 275,000 hectares of the semi-arid, rabbit prone lands of the South Island high country (RLMP News, October 1989). There were 53 Otago properties in the programme, 37 from Canterbury and 5 from Marlborough. The significant rabbit problems in New Zealand are still largely confined to the semi-arid lands so these areas are the focus of this report. Table 1 shows the overall distribution of rabbit proneness categories across the whole of New Zealand.

One of the aims of the programme was to reduce rabbit numbers to low levels and to leave the participating properties in a financial position that would enable them to economically sustain the control work required to maintain rabbits at these low levels (RLMP News, December 1991). This aim was achieved on some properties, but others still had significant areas with rabbits at moderate to high levels at the end of the programme. Many properties were still struggling economically because of poor farming returns at the time. Rabbit populations continued to increase, with landholders poisoning as much of their affected land as they could afford (RLMP News March 1995 - Awatere Valley Field Day Report). In most cases the inputs of the programme such as rabbit proof fences still provided essential help in addressing the problem.

In 1989, while the RLMP was in operation, a joint research programme between NZ and Australia began to assess the possible use of a calicivirus as a biocontrol for feral rabbits. While field evaluations were being carried out in 1995 on Wardang Island off the South Australian coast, the virus escaped onto the mainland. Initially, New Zealand and Australian authorities referred to the disease it caused as ‘rabbit calicivirus disease’ (RCD), but subsequently they adopted the internationally recognised name of rabbit haemorrhagic disease (RHD)

The RCD Applicant Group, Chaired by Graeme Martin (Chief Executive of the Otago Regional Council) was then formed in New Zealand, comprising representatives from the Hawke’s Bay, Canterbury, Otago and Southland Regional Councils, Marlborough District Council, the Commissioner of Crown Lands and Federated Farmers of New Zealand (RCD Applicant Group, 1996).

In Australia, the virus proved to be very effective, decimating rabbit populations in the drier south-eastern parts of the country. Research on the virus pertinent to the NZ situation continued. Many landholders now saw the virus as the only solution to their high

rabbit numbers. The Applicant Group first undertook a thorough assessment of the potential biocontrol, taking advice from experts in Australia, USA and the UK and a virology expert panel formed for the purpose. Then, in 1996, it submitted an application to the Director General of Agriculture to import the virus comprising several hundred pages of review and conclusions and a further seven hundred and fifty pages of reference material (RCD Applicant Group, 1996). The decision to reject the application was called into question by the Prime Minister, the Minister of Agriculture, farming leaders and many others and the illegal introduction of RHDV into New Zealand in 1997 was subsequently acknowledged by the decision-maker as 'probably an inevitable consequence' of that decision (O'Hara, 2006). Although it was present in the Mackenzie Basin in June of that year, it was not until the autopsies of dead rabbits collected near Cromwell in August that the presence of RHDV was confirmed.

MAF attempted to contain the outbreak and advised that any persons in the possession of virus material would face harsh penalties. This did not deter some landholders from promoting the spread of the virus by collecting dead rabbits and spreading them on their farms and even using planes to drop them onto new areas. Livers, hearts and lungs of dead rabbits were pureed in food processors with water and the resulting solution, referred to as home brew (and even 'rabbit smoothie), was strained and sprayed onto baits such as oats and carrots. The baits were aerially or ground spread onto rabbit infested areas.

After the MAF announcement that it was no longer illegal to be in possession of the virus, many other landholders actively engaged in spreading the virus onto their properties. Virologists warned that the home brew method risked inoculating rather than killing rabbits.

Following the RHDV introduction, there was an immediate and dramatic decline in rabbit populations with reductions at monitored properties varying from less than 20 percent to 90 percent (Lough, 1998).

However since the mid 2000's, rabbit densities have increased on some properties and serological testing has shown that increasing proportions of live rabbits have been exposed to the virus and survived (ECan and Otago Regional Council reports).

4. Regulatory framework in brief

The Biosecurity Act 1993 (and its amendments) requires the management or eradication of pests to be in accordance with pest management strategies. No national pest management strategy for the rabbit pest has been established but many councils in New Zealand have included rabbits in their Regional Pest Management Strategies, with varying requirements on occupiers and varying funding arrangements (refer to section 13). Within these strategies, councils have set maximum allowable limits (MAL) for rabbit population densities which are assessed by on-ground inspections and expressed in terms of the Modified McLean Scale (8.1.6).

5. Rabbit haemorrhagic disease

Rabbit haemorrhagic disease virus (RHDV) is a single stranded positive sense RNA virus that infects European rabbits (Oryctolagus cuniculus). Infection with the virus leads to the rapid development of acute rabbit haemorrhagic disease (RHD), which is usually fatal for naive rabbits in susceptible age categories without genetic resistance. RHD has resulted

in very high levels of mortality in susceptible individuals and populations of rabbits in over 40 countries, it causes rapid death, with most infected rabbits dying within 48 hours of the onset of clinical signs. Rabbits appear to suffer minimal discomfort (RCD Applicant Group, 1996).

Young rabbits below the age of about 10 weeks usually survive viral challenge to become immune for life and will go on to breed unless they die by natural control factors or because of rabbit control measures undertaken by land managers. Passive immunity from acquired maternal antibodies may provide protection for a time but will eventually be lost, this means that the offspring of immune does could normally expected to become fully susceptible by the time they are a few months of age, provided they are not exposed to viral sources when young and provided they are not genetically resistant to the virus (refer to section 10) (RCD Applicant Group, 1996).

Therefore, if the virus were to be ubiquitous and able to be transmitted throughout the rabbit breeding seasons, then the widespread exposure of young rabbits before the age of susceptibility (to then gain immunity) could be expected to diminish its impact on rabbit populations over time. It might be surmised that in high-density rabbit populations a higher proportion of young rabbits would gain immunity over time through greater opportunities for exposure to the virus; this has not been determined in New Zealand.

There is an un-quantified potential in New Zealand for rabbits of any age to gain immunity following exposure (e.g. by ingestion) to inactivated virus by means such as coprophagy, ingestion of biocide baits or fly spots (refer to section 10). Recent international research suggests that the virus could be selecting a rabbit blood group sub-population for survival that is unable to be infected owing to the lack of the correct blood group viral receptor (Guillon P et al 2009) (Atkinson, pers. comm.) (refer to sections 8 and 10).

6. Impacts of rabbits

6.1. *Environmental impacts*

Historically, grazing and burrowing by rabbits has caused major damage to soils and vegetation and markedly altered landscapes (RCD Applicant Group, 1996) (Working Party on Sustainable Land Management, 1994). Early overgrazing by sheep and frequent burning were also significant factors but these practices are uncommon today. Grazing by rabbits is still closely inter-linked with that of sheep and contributes to low, open vegetation, bare ground, an increasing abundance of unpalatable species such as thyme and a reduction or loss of palatable species such as blue wheat grass, plume grass, blue tussock, fescue tussock and inter-tussock species (Allen et al, 1995).

Those charged with making recommendations or policy decisions relating to rabbit management in the high country would find their roles much easier with a clear separation between the impacts of rabbits and those of farmed animals such as sheep, and a separation between the relative impacts of rabbits and sheep on productive versus environmental values. There is a view in some regional councils that further effort could be made to differentiate these impacts. However the mix of herbivores (sheep, rabbits, hares, cattle, deer, invertebrates and even wallabies) and variability in climate, vegetation, stocking rates, farm management practices and in the vulnerability of the land, makes a clear separation of impacts a very difficult goal to attain. There would need to be compelling reasons for attempting it (see section 14.1); informed judgement is required.

'*It is difficult to directly link vegetation changes with declines in rabbit populations because other factors, such as climate, farm stocking rates, etc, are interrelated.*'
(Working Party on Sustainable Land Management,1994).

'It is difficult to relate vegetation change and land degradation to causes. The effects of grazing by rabbits and farmed stock (especially sheep) and burning are inextricably linked and are not simply additive, Hence we have been unable to clarify the particular role of rabbits in the overall decline of vegetation and soils.
(Allen et al, 1995)

'*It is difficult to quantify the economic or environmental effects of changing rabbit populations.'*
(RPMS for Marlborough: Operational Plan Report 2008/2009)

The National Vegetation Survey Database, being developed by Landcare Research Ltd, holds a collection of vegetation monitoring done in New Zealand and includes the annual vegetation monitoring that was undertaken over the five years of the Rabbit and Land Management Programme. After the RLMP ended, some farmer based landcare groups continued to carry out vegetation surveys on semi-arid land properties.

If this data were available for analysis it might allow a better understanding of the changes that have occurred since the end of the RLMP and give a perspective on what will occur should rabbit populations increase again. However, it is unlikely that the monitoring would enable broad interpretations on the differential impacts of different grazing species on environmental and productive values.

Even though their impacts can not be clearly differentiated from the effects of other grazing factors, there is no doubt that rabbits pose a major threat to the health and integrity of ecosystems and habitats within the semi-arid lands, and they are a direct threat to the survival of numerous threatened plant species present. Maintaining low numbers of rabbits is necessary to prevent damage to ecosystems, threatened plants, their habitats and ultimately the soil, sometimes with subsequent effects on water values.

Plant communities with specific conservation values, and threatened species, can be vulnerable to rabbit (and sheep, deer and cattle) grazing. The Department of Conservation has recently reviewed the potential impacts of rabbits on ecological values in Canterbury (Head, 2009).

'Direct impacts of rabbits on threatened plants include selective browsing on palatable species. This causes premature mortality and/or reduces the vigour and reproductive output of individuals. In turn this leads to fragmented populations, fewer populations and smaller numbers of individuals. In addition to increased mortality and reduced plant vigour, rabbits browse flowers, seeds and seedlings. This prevents seedling recruitment and causes populations to become dominated by mature and 'moribund' individuals, further reducing resilience and vigour of threatened plant populations.'
(Head, 2009).

The Tekapo Scientific Reserve provides a good demonstration of the impact that grazing by rabbits and sheep can have on fragile semi-arid land. In 1992 the vegetation there comprised exotic weeds, bare ground and little tussock. Since then, the removal of sheep and a reduction in rabbit populations has led to a significant recovery – tussock cover has increased while the abundance of weeds and the amount of bare ground has decreased.

'*A high diversity of native inter-tussock species is now also present, including good populations of several dryland rare and threatened plant species. Shrub species are also returning as a result of the recovery of old 'suppressed' plants and from renewed seedling recruitment … this recovery emphasises the importance of controlling rabbits, not only to prevent ecosystem degradation, but to allow for recovery of indigenous biodiversity*. (Head, 2009).

High rabbit numbers also pose an indirect risk to valued fauna such as birds, lizards and invertebrates that are vulnerable to rabbit predators (RCD Applicant Group, 1996). This impact is usually highest when breeding and nesting occurs, with both adult and young being put at risk. When rabbit populations are allowed to reach very high levels over time, and then removed by primary poisoning (e.g. 98% kills), there is a heightened risk that the predators previously supported by the high rabbit population will turn to native prey for sustenance. Prey switching is less likely following RHD epizootics because of lower kills and the fact that young rabbits with natural resistance remain as prey (RCD Applicant Group, 1996). The risk of prey switching can be avoided by maintaining rabbit numbers at low and stable levels.

The reduction in rabbit populations following the arrival of RHD in 1997 appears to have favoured the spread of wilding trees in some rabbit prone areas (Fastier, pers. comm.) (Henning, 2005); this outcome was predicted (RCD Applicant Group, 1996) and illustrates the importance of maintaining a systems approach to pest management rather than focussing on a single pest. It is inconceivable however that rabbits should be regarded as a 'desirable' biocontrol for wildings.

A survey found that most farmers considered that damage to the soil was the main impact of rabbits (Henning, 2003). Direct damage by burrowing can be very significant in some areas; it can damage machinery such as hay/baleage/winter feed making equipment, cause leakage in border dykes and possible damage to irrigation head-races. Widespread indirect damage occurs when overgrazing of vegetation by rabbits and sheep exposes soils to erosion by wind and water. Loss of soil in this manner effectively means the loss of a non-renewable resource in human time scales, especially in the semi-arid lands of New Zealand.

The Department of Conservation is often criticized for harbouring rabbits on conservation lands. Although the Crown can choose not to be bound by Regional Pest Management Strategies, the Department endeavours to meet the same requirements as apply to surrounding private land. In Otago there are no examples where the Department has not met council requirements (Robson, pers. comm.). Often rabbits are maintained at lower levels than required by councils - to minimise risks to particular ecological values (for example at Flat Top Hill Reserve near Alexandra). Total expenditure on rabbit control in conservancies for the 2008/2009 financial year was approximately $220,000 (MAF, 2009).

Rabbit populations on most of the land administered by the Department of Conservation in Canterbury are stable, with some local infestations. DOC considers that numbers can be held down as long as funding remains constant. In Otago, conservation areas are mostly below MMS 3 apart from some hotspots (Kennedy, pers. comm.).

Land Information New Zealand (LINZ) conducted five successful control programmes on other Crown land in 2009 and has two other areas under notice (section 9.7) in Canterbury. LINZ expenditure on rabbit control programmes in 2008/2009 was $210,000,

with an additional 45 days of internal staff and external project management time spent supporting these programmes (MAF, 2009).

One hundred and fifty years under a pastoral regime, early fires and a history of repeated 'explosions' in rabbit populations have markedly modified the original vegetation of the semi-arid lands. In large areas then, the main environmental threat posed by rabbits is to soil and landscape values. By the time rabbit populations reach levels at which significant soil loss is occurring, it is very likely that farm business values (actual and potential grazing) have already been largely lost. Subsequent soil loss then becomes a matter of public interest, especially on Crown owned land, because of externalities such as offsite threats to water values and, more importantly, the intergenerational impact of the loss of the soil resource. Regional councils have indicated that such overt environmental impacts are now uncommon.

6.2. *Economic impacts*

Reddiex and Norbury (2005) concluded that '*there is no way at present to assess the marginal costs and benefits of rabbit control*', this is confounded by the inability to differentiate the impacts between the combined effects of grazing by sheep and rabbits. Furthermore, the inability of such analyses to adequately account for the environmental impacts of rabbits means that direct comparisons between production and environmental costs and benefits are not available to inform decisions on rabbit management or funding.

The impacts of rabbits on land-based businesses include:

- Short term direct grazing losses (otherwise available to livestock)
- Longer term grazing losses through modification of vegetation cover and composition
- Financial costs of rabbit control
- The major disruption to grazing management associated with the need to spell from grazing any land treated with 1080 until sufficient rain has fallen to make it safe to livestock
- Loss of soil (at high densities)
- High rabbit populations assist in maintaining high predator numbers. 'This can lead to significant costs being incurred in situations where predators carry bovine tuberculosis' (ECan RPMS).

The RCD Applicant Group noted that one stock unit equated to about 12 rabbits. In the Mackenzie, counting of poisoned rabbits above and below ground (excluding those taken by hawks), on numerous half and one-hectare plots, found up to 62 rabbits per hectare (Robertshaw and Robson, 1990). However rabbit densities are not usually measured in numbers per hectare but by indirect estimates such as night-counts and the Modified McLean Scale. Furthermore, a simple substitution does not account for their effects on vegetation composition and soils (Allen, et al, 1995). Brown Copeland and Co (cited in RCD Applicant Group, 1996) estimated the annual costs of rabbit control to landholders and regional councils to be 'a minimum' of $12.6 million. The Applicant Group suggested that $22 million was a more realistic assessment. Nimmo-Bell (2009) estimated the current annual production losses due to rabbits at $50 million, citing an earlier report by Bertram (1999) in which it had been estimated that 2.0 million sheep were being displaced by rabbits (at a 1999 value of $25 per head). In reaching this estimate, Nimmo-Bell assumed that by 2009 rabbit populations had halved and that livestock values had

doubled. It is simplistic to assume that sheep could replace rabbits - uncontrolled grazing by rabbits often leads to a level of overgrazing that a prudent farmer would never accept.

Following the arrival of RHD, the cost would have fallen dramatically, especially with many properties undertaking little if any secondary control. One large Mackenzie property reported a three to five-fold reduction in control costs after the arrival of RHD but has recently undertaken several primary poisonings; further poisonings are not anticipated there for several years.

Others have continued with more stable annual expenditure. For example $2 to $4 per stock unit (Tekapo), $3 and $7 per stock unit (Central Otago). Consistent annual expenditure is often easier to manage in a farming business. Direct economic comparisons between a policy of periodic primary poisons or ongoing stable secondary control should not overlook the risks associated with allowing survivors of RHD to remain and breed (refer to sections 9 and 10).

Assessments of the control costs per hectare of rabbit prone land might enable more informed comparisons between properties of similar rabbit proneness. Between-farm comparisons are complicated by differing proportions and levels of rabbit prone land, and by local factors such aspect, terrain and ground cover. Some high-cost primary poison operations have been cited by farmers - $90,000, $60,000, $34,000 in 2008 on 3 different Mackenzie properties ranging from 9,500 to 28,000 stock units (the first of these was a failure, almost certainly due to deficiencies in the operation). However, such costs do not necessarily reflect annual averages over the 12 years since the arrival of RHD, especially where little or expenditure has been incurred in the meantime.

7. Early predictions about RHD in New Zealand

After reviewing what was known about RHD internationally, the RCD Applicant Group predicted that, in New Zealand, the virus would:

- transmit between rabbits;
- cause high mortality in medium to high density populations;
- spread rapidly over long distances—naturally, accidentally or induced by humans;
- spread slowly locally;
- be impossible to contain; and
- persist in the environment.

Each of these predictions has been borne out. However, the Applicant Group made a particular point of stressing that:

'*[RHD] should not be seen as a low cost single tool for rabbit control. Effective population reductions achieved through an [RHD] epizootic must be maintained to the maximum practicable extent by use of conventional control techniques.'* It warned '*Defeat of any single control tool occurs when it is used too frequently and in isolation from other control tools. The most recent New Zealand example is the toxin and bait shy rabbits that have resulted following excessive reliance on poisoning with 1080 dosed baits.'*

(RCD Applicant Group, 1996).

Even before the application to import RHD was submitted, the Rabbit Biocontrol Advisory Group in MAF pointed to the need to use other control measures to target survivors of RHD:

'*It is possible, therefore, that rabbits may develop resistance to [RHD] and/or [RHD] may become less virulent. This has happened with the myxoma virus that causes myxomatosis. If [RHD] is used as a rabbit control tool, it will not be a 'magic bullet'. Plans would be developed with land managers to integrate [RHD] with other control measures, to maximise the long-term impact on rabbit numbers.'*

'Maternal antibodies can be passed to young and confer immunity: however, this immunity is short-lived. The next generation of young become susceptible and [RHD] can spread through the population again. This means that, if [RHD] is introduced in New Zealand, it will be necessary to combine [RHD] with other control methods to provide effective rabbit control.'

(Rabbit Biocontrol Advisory Group, 1996)

The unauthorised import and spread of the virus led to circumstances that, for a time, were less than ideal for disseminating these important messages.

8. Rabbit populations

8.1. *Monitoring Rabbit Population Trends*

Regional/District councils with semi-arid land (SAL) in their regions have carried out rabbit trend monitoring, principally using night-counting, since they were first established. In some cases this was a continuation of the night-count routes that were set up during the time of Pest Destruction Boards or later during the RLMP. Following the arrival of RHDV, the councils intensified their night-counting programmes in order to better track the changes that occurred in rabbit numbers. The night-count routes are very extensive but still only sample a portion of the land within each region. However regional councils have all indicated that the data gathered support their observations on other properties.

The other widely used method of assessing rabbit population density is to record ground sign using the Modified McLean Scale (see section 8.1.6).

Night-counting

Night-counting is a method used to determine rabbit trends and has been used in New Zealand since the late 1960s. Councils use a standard procedure for night-counting, so that all data collected in NZ is comparable (Rabbit Managers Fact Pack, 1992). The method involves travelling along a set marked route on a motorcycle using a spotlight to count the rabbits seen in the light beam. The counts are repeated over the next two or three nights of good weather.

Count routes are selected so that the various levels of rabbit proneness, topography and vegetation found in the region are represented. Routes can be entirely within a single property but they often cover several. It is important that various rabbit control programmes are represented in the surveillance work, from landholders with very effective programmes through to those with no human input.

Councils use a number of count routes within a district so that a wide representation of the rabbit populations is obtained. This also helps to avoid the risk of localised events unduly influencing the results of the monitoring programme. A typical 'event' is a winter

poison operation where poisoning occurs within a count route. As a result, rabbits counted subsequently drop off dramatically along that route but such a decline may not represent the area as a whole.

In Otago, night-counts have been carried out annually in the late winter - the period when rabbit numbers are most stable. This provides a good indication of the potential breeding population existing at the start of the main rabbit breeding season.

8.1.1. Rabbit population trends in Canterbury

There has been a general increase in rabbit numbers in the Canterbury region over the last few years. The following material is based on information contained in ECan's report on the latest night-count results and includes excerpts and graphs directly from the report (Canterbury Regional Rabbit Trends, 2008).

Counts carried out in the spring of 2008 indicated that rabbit populations had increased in nine of the region's eleven pest districts since 2007. Typical population increases are shown in Figure 2.

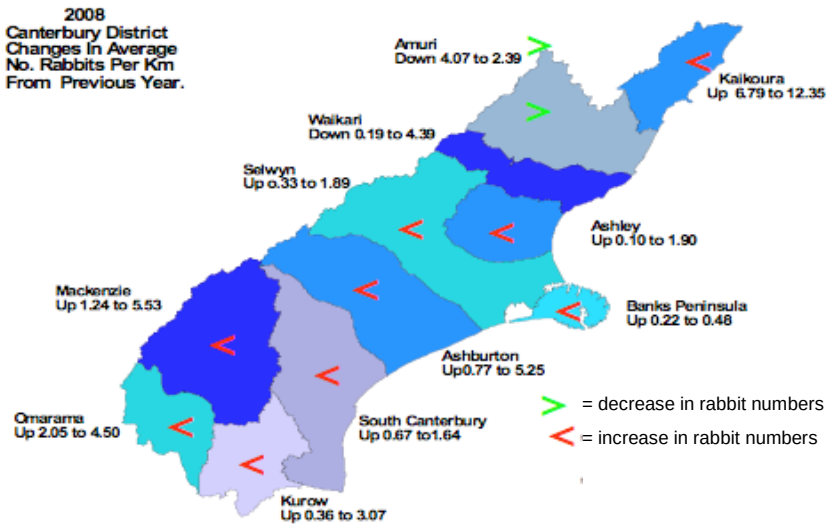


Figure 2: District changes in average rabbits per kilometre

(source: ECan)

Of most concern are those districts where the mean number of rabbits has increased by more than one rabbit per kilometre of monitoring transect. These are the Mackenzie (sixth consecutive annual increase), Omarama and Kaikoura districts. Not coincidently, these districts also contain the most highly prone lands in Canterbury. The semi-arid rabbit prone land is represented by the Mackenzie, Kurow, Omarama districts.

The rise in rabbit numbers in these nine districts occurred in spite of the application of approximately eight hundred tonnes of carrot for 1080 primary poisoning in Canterbury during the winter of 2008 and an unknown quantity of pindone pellets being used for rabbit control throughout the region (< two hundred tonnes used in 2007).

Rabbit populations are likely to continue to increase in parts of the Mackenzie, Kurow, Omarama, Waikari, Amuri and Kaikoura districts (ECan, 2009).

The remaining pest districts of South Canterbury, Selwyn/Plains, Banks Peninsula and most of Ashburton and Ashley have rabbit populations that are considered to be stable. RHD epidemics, rainfall, disease, predation and some secondary control is effectively containing numbers at present in these areas.

The Mackenzie Basin is considered to be the most rabbit prone district in the Canterbury region and rabbit populations there have been steadily increasing since 2004 (Figure 3).

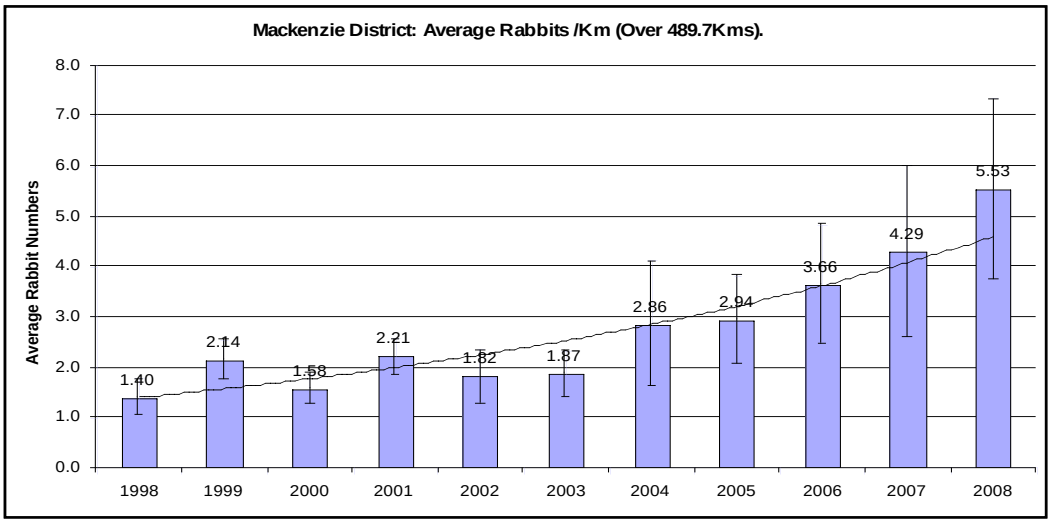


Figure 3: Mackenzie Basin District Annual Mean 1998-2008)
(95% confidence interval error bars) (Source: ECan)

The Mackenzie night-count transects in Figure 3 cover 489.7 km over twenty-three properties.

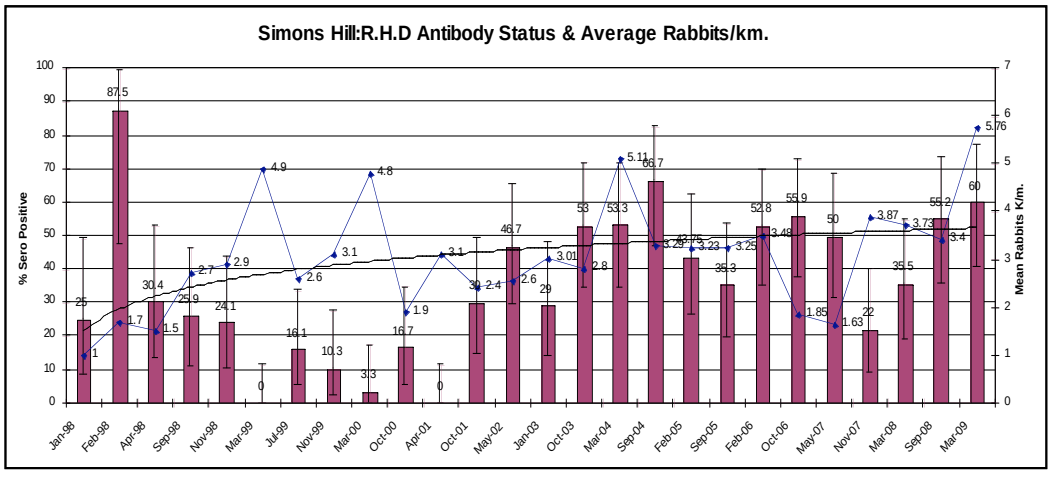


Figure 4: Antibody status and rabbit population trends at Simons Hill
(Source: ECan)

The figure shows the percentage of the sample seropositive to RHD (purple bars), trends in the average number of rabbits counted per spotlight kilometre (blue line) and the average trend of seropositivity (black line). (95% confidence interval error bars)

Figure 4 illustrates what has happened on a property where regular day shooting and night-shooting is undertaken 3 days and 3 nights per month; fumigation of burrows after winter snows has been very effective (Fastier, pers. comm.). Simons Hill has maintained a strong rabbit control programme since before RHD first arrived in the Mackenzie Basin.

The last transect monitored in early 2009 shows a significantly higher level of recruitment over the last breeding season but, despite this latest increase, the property has had one of the most static rabbit populations in the Mackenzie over the last decade, and patch poisoning has not been required since the introduction of RHD in September 1997.

The landholder advises caution in the interpretation of this night-count data, pointing out that a considerable portion of the night-count route is in an area that receives negligible secondary control, yet has the lowest population density. It is his view that dramatic changes in the vegetation of this rabbit fenced block (loss of short tussock and increase in Hieracium), and the lack of any moist areas at all, have markedly reduced its suitability as rabbit habitat (Fastier, pers. comm.).

The trends prior to the introduction of RHD are shown in Figure 5, which represents night, count figures in three areas within the Mackenzie Basin over a longer term. Although rabbit levels show peaks and troughs, which can be attributed to breeding pulses and RHD epidemics, overall there is a recent increasing trend. Of interest also are the changes which have occurred within the three time periods of the Rabbit and Land Management Programme, the change to 'user pays' (in which the farmer pays the full cost of rabbit control, with no Government contribution) and after RHD arrived.

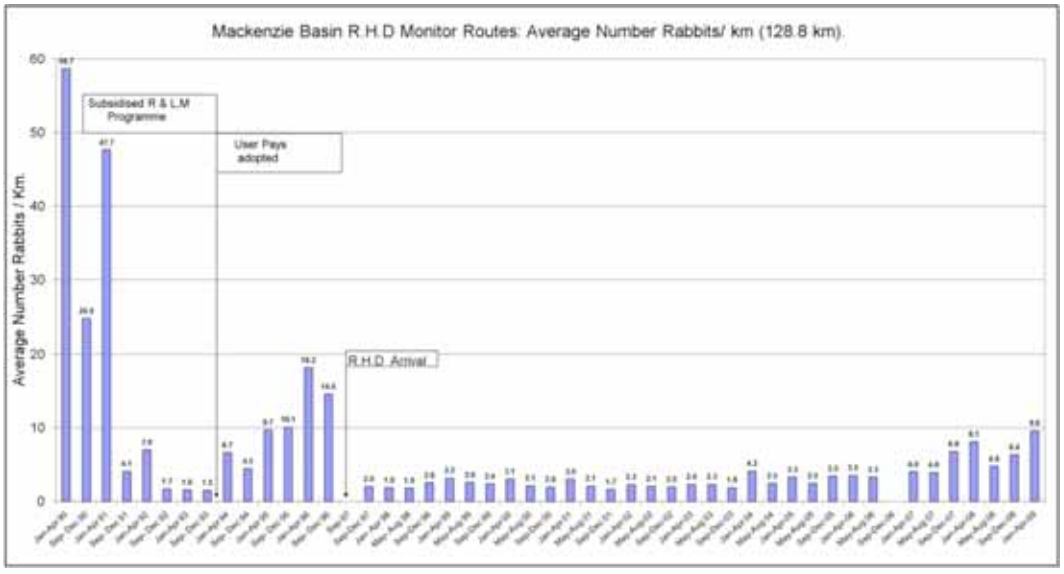


Figure 5: Mackenzie Basin, average night-counts on 3 RHD routes 1990-2008
(Source: ECan)

8.1.2. Canterbury serology

The results of serological monitoring must be interpreted with caution. First, it cannot be assumed that the percentage of a rabbit population testing seropositive represents the percentage immune (refer to sections 8.1.4 and 10). Second, variations between years in the interval between the most recent epizootic and sampling date, the recruitment since and overall rabbit density will affect the results. The proportion seropositive is likely to be higher immediately after an epizootic, but there can be no certainty as to when an

epizootic occurred, or whether viral challenge has continued after an apparent epizootic. Local observations indicate that these events appear to be becoming more localised and less defined. Many other factors may be involved (refer to section 10.4).

Although estimated average levels of rabbits showing RHDV antibodies (assessed using the cELISA test) have been stable at about 50% in the monitored populations of some Canterbury districts since 2006, rabbit abundance is increasing. Presence of RHDV antibodies might or might not translate to immunity but nonetheless the level of rabbits thought to be immune is held to be increasing every year. It is also probable that the virus is selecting a rabbit blood group sub-population for survival that is unable to be infected owing to the lack of the correct blood group viral receptor (Guillon et al, 2009). This sub-group cannot be infected but nonetheless could have RHDV antibodies arising passively from coprophagy, virus on baits or from fly vector faeces on grass for example.

For the Mackenzie Basin, fluctuations in the proportion seropositive over a year can be seen in Figure 6. Figure 4 shows the results for a property that receives regular secondary control. Again, apparent trends must be interpreted with caution and it is important not to lose sight of the goal – low-density rabbit populations. So it is significant that, in recent years, the rabbit densities on the property in Figure 4, which receives ongoing secondary control, were well below the Mackenzie averages shown in Figure 5, despite similar serological profiles (refer also to Otago Serology in section 8.1.4).

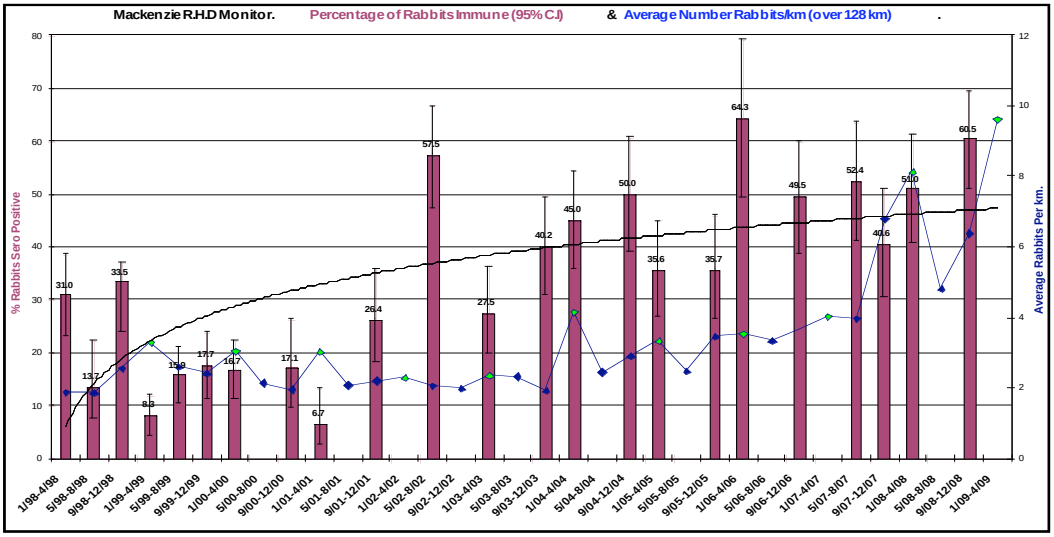


Figure 6: Population trends and percentage seropositive in the Mackenzie

(Source: ECan)

The figure shows the percentage of the sample seropositive to RHD (purple bars), trends in the average number of rabbits counted per spotlight kilometre (blue line) and the average trend of seropositivity (black line) (95% confidence interval error bars).

8.1.3. Rabbit population trends in Otago

Most New Zealand land of extreme rabbit proneness is in Otago. The Otago Regional Council has well-established population and RHD serology monitoring programmes in place. Inland Otago is considered to have the most rabbit prone lands, with the other districts currently having relatively low and stable rabbit populations (see the Coastal/Lowland example in Figure 7). While 2009 counts are not yet available; field

observations indicate that, following the arrival of RHDV, rabbit populations in these other areas are low and stable. Therefore comments and data for the Otago region are restricted to that land which lies within the semi-arid inland areas.

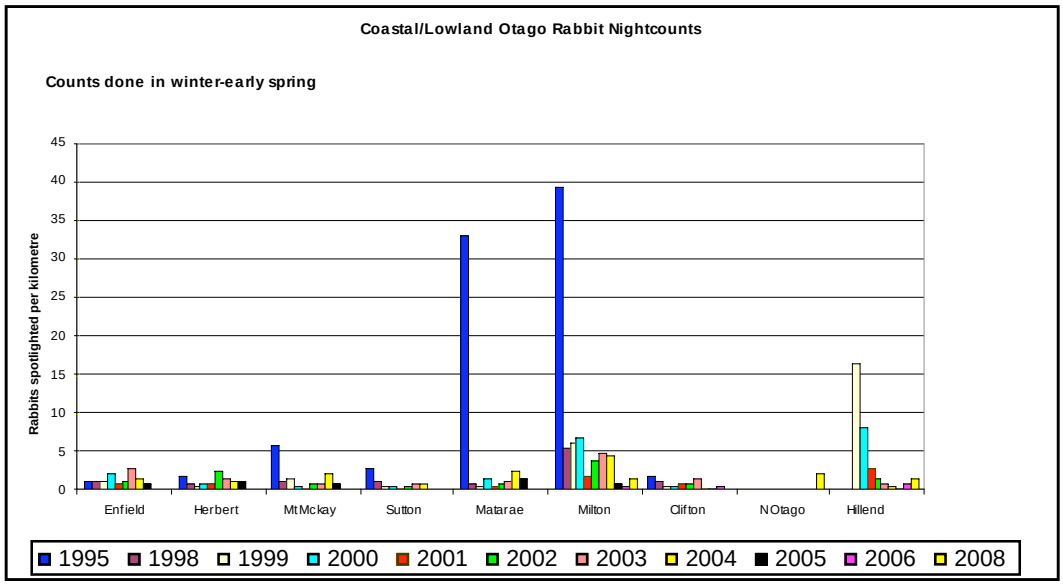


Figure 7: Rabbit population trends in coastal and lowland Otago
(Source: Otago Regional Council)

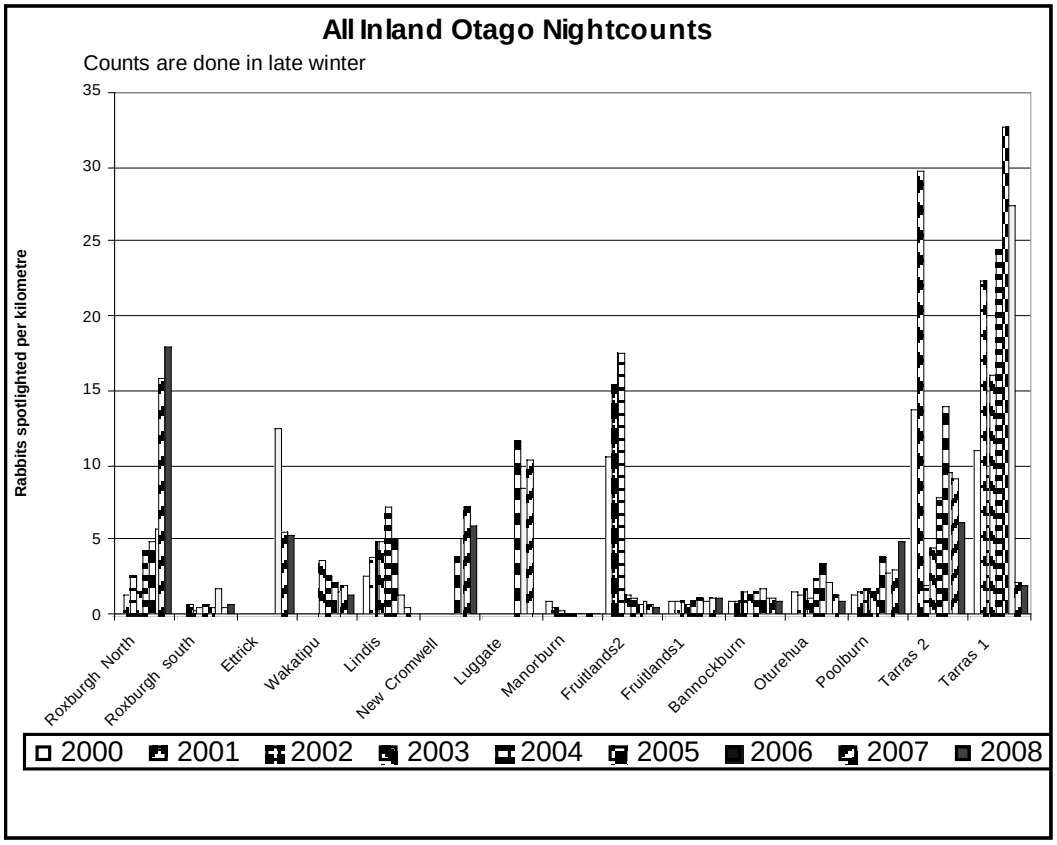


Figure 8: Population trends in inland Otago
(Source: Otago Regional Council)

Figure 8 shows combined Inland Otago night-count monitoring results for the RHD monitor sites and the normal night-count routes. Night-count results for Inland Otago show large fluctuations; the dramatic reductions seen in rabbit numbers are the result of poison programmes on some sections of the night-count route.

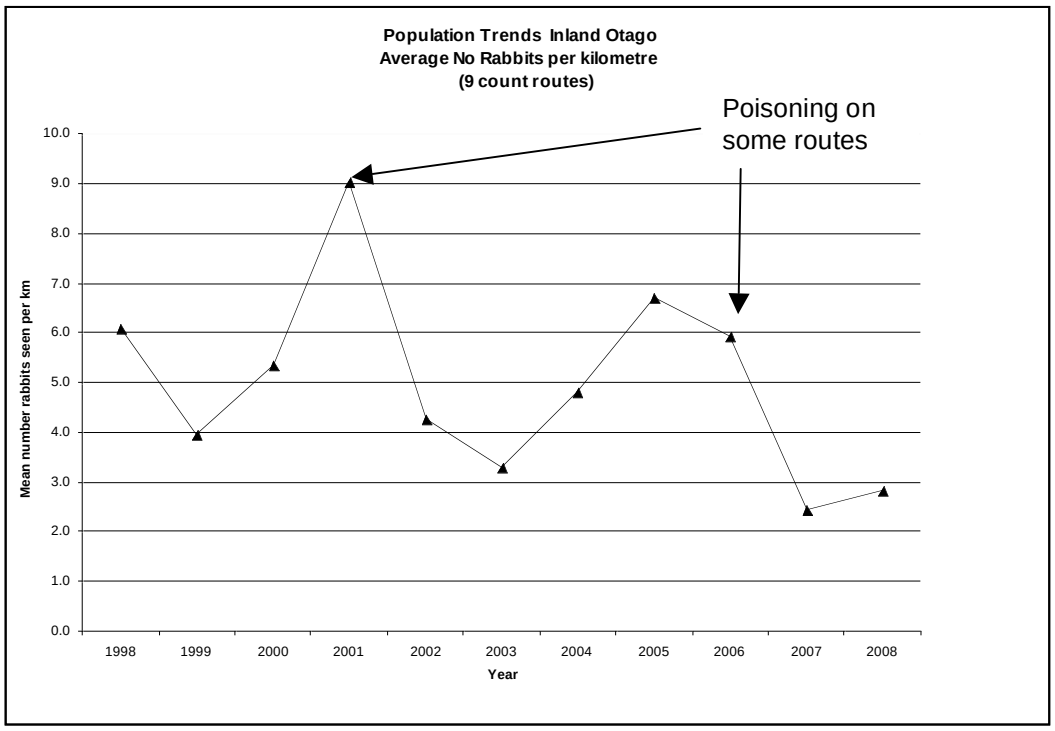


Figure 9: Population trends on Inland Otago RHD monitoring sites

(Source: Otago Regional Council)

Figure 9 shows the annual trend in rabbits counted on the Otago Regional Council's nine specific RHD monitor sites that lie within the semi-arid lands. It illustrates the continued decline in rabbit numbers through to1999 following the initial dramatic decrease in rabbit numbers that occurred throughout the rabbit prone lands of the South Island following the release of RHD in 1997. The majority of landholders in Otago stopped rabbit control work as it appeared then that the virus would continue to reduce rabbit numbers further. Some felt that surviving rabbits might be necessary to ensure the virus would remain present on their property. However night-counts in the winter of 2000 showed that rabbit numbers had begun to rise again; this confirmed the observations of many landholders. Many began to apply secondary control methods again, albeit at a much lower intensity than prior to RHD. By about 2003 the Otago Regional Council's rabbit serum testing programme for RHD antibodies began to show an increasing level of RHD seropositivity in the region's rabbit populations. Most landholders acknowledged the council's advice that the intensity of secondary control effort would need to be further increased.

In 2008, the average number of rabbits on these count routes varied from 0.1 to 6.4 per km, with a slight increase over 2007 numbers. The data for 2009 is not available yet.

The level of rabbit control varies on each route, from properties where a long-term intensive night-shooting and fumigation programme is in place through to properties where little effective control is undertaken. Several of the night-count sites receive what could be termed 'moderate control' (usually night-shooting or helicopter-shooting) which

involves one or two passes over the property annually. Fumigation is usually done in conjunction with ground shooting,

The highest value for any count route in 2008 was an average of 9 rabbits per km, but **most of the routes currently have average levels in the 1-3 rabbits per km range and are representative of the majority of inland Otago properties**. Field observations and the night-count results (see also Figure 10) show **a strong correlation between control effort and rabbit population densities** - the greater control effort the lower the rabbit population (Robson, pers. comm.).

The principal factors attributed to low to moderate rabbit levels are effective secondary control programmes, RHD, and the various agents that cause natural mortality in rabbit populations.

So while there are properties in Otago that have high rabbit numbers exceeding the allowed levels set down in the Regional Pest Management Strategy, the majority of landholders have responded to the reality that unless they carry out control, be it primary or secondary, they risk the daunting prospect of funding the large scale control operations that would be required to return their rabbit populations to low levels.

Figure 10 illustrates population trends in four of the RHD monitor sites in more detail (error bars not available). There have been wide differences in values between sites in certain years. As explained previously, these properties have had differing levels of rabbit management.

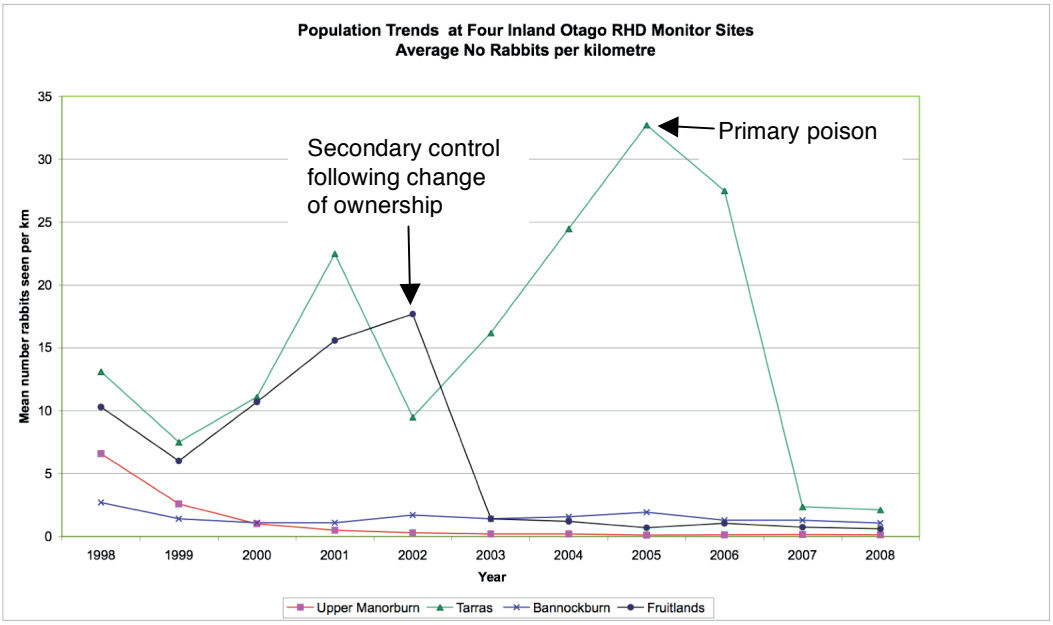


Figure 10: Individual monitor site population trends in Inland Otago

(Source: Otago Regional Council)

The Tarras site uses poisoning as a regular method so rabbit populations rise to high levels then fall to very low levels, with night-shooting then being applied for the next few years. In contrast, the Upper Manorburn site is subject to an intensive on-going night-shooting regime which holds rabbits at very low levels. Just prior to RHD, this site had a count route average of more than 95 rabbits counted per km.

At the Bannockburn site, ground and helicopter shooting is used to control rabbits. The Fruitland site represents the majority of Otago's semi-arid land properties by using

night-shooting; any active warrens seen are fumigated while shooting. A competent pest operator covers the whole property two to three times a year.

In addition to night-count population trend monitoring, the councils undertake comprehensive rabbit density assessments based on extensive on-ground inspections covering tens of thousands of hectares (refer to section 8.1.6). For Otago, the combined night-count monitoring, on-ground inspections and observations show that …

... almost all those Otago properties judged to be the most rabbit prone in NZ during the 70's and 80's, and subsequently classified as 'extreme' in the Rabbit and Land Management Programme, currently have rabbits well under control and have managed this without external funding for rabbit control for at least 12 years.

Without the increasing level of secondary control by landholders in the rabbit prone areas of inland Otago, it is likely that rabbit populations there would have increased in a manner similar to those of Canterbury and Marlborough.

8.1.4. Otago Serology

Trends in average seropositivity to RHD in central and coastal Otago are shown in Figure 11. Details of the Otago 2009 serology are not yet available. Again, care is required in the interpretation of these results (refer to the comments in sections 8.1.2 and section 10) to distinguish the difference between 'seropositivity' (what is actually measured) and 'immunity' (best determined by controlled challenge studies) which, though related, are not necessarily the same thing. In human or other animal populations where viruses are only encountered by infection the distinction probably does not matter, but rabbit populations are also able to encounter significant virus passively (baits, coprophagy, fly faeces) altering how one interprets seropositivity. Surviving rabbits with seropositive titers might not be immune at all but rather a genetically resistant selected sub-population unable to get the disease; unlike immunity, genetic resistance is a heritable characteristic (refer to section 10.1). Without secondary intervention, this would likely be a growing proportion of the total rabbit population.

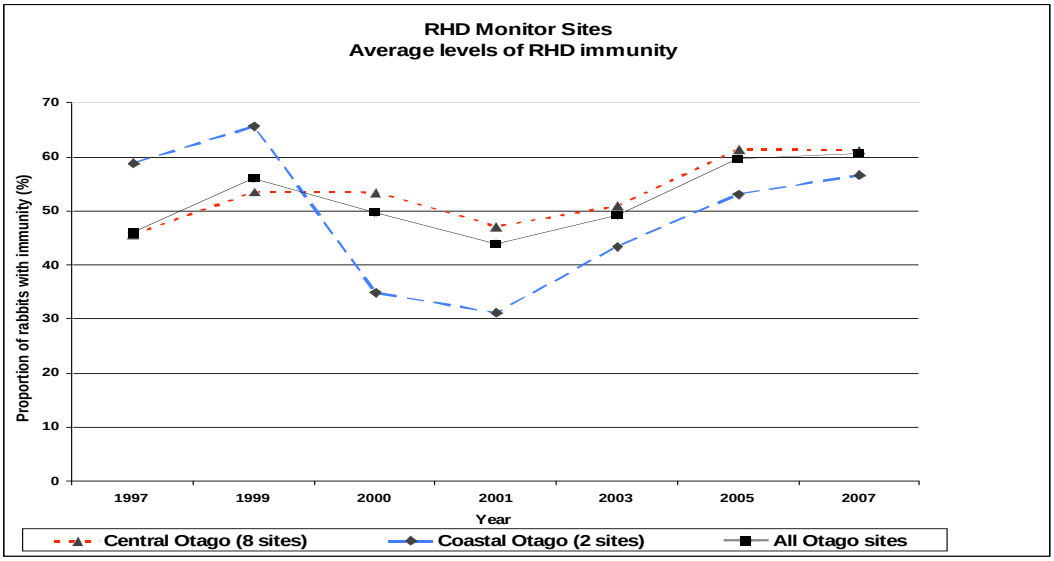


Figure 11: Trends in average antibody status in Otago

(Source: Otago Regional Council)

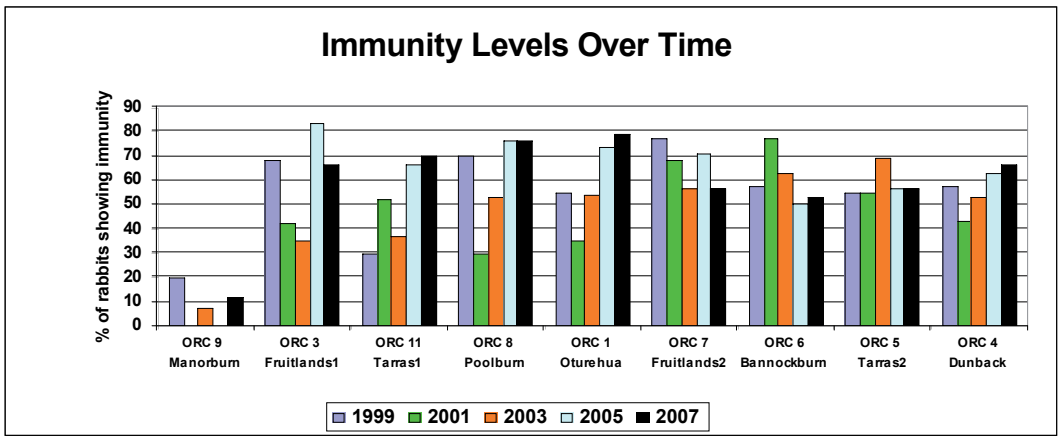


Figure 12: Trends in seropositivity - Central Otago

(Source: Otago Regional Council)

Of the individual sites at which RHD serology is monitored, the Manorburn site has consistently showed a much lower proportion of seropositive rabbits. Ongoing secondary control has held rabbit populations at very low levels on this highly rabbit prone property (Figure 10). However, there are other sites (e.g. Bannockburn, Figure 10) at which populations have also been held to very low levels where the percentage seropositive has ranged between 50 and 70 percent (Figure 12).

8.1.5. Rabbit population trends in Marlborough

The data for the following graphs are collected from the Marlborough District's most rabbit prone land. They show trends for blocks on properties in the Upper Awatere Valley. There is typical variation between blocks but some rabbit populations have been rapidly increasing.

There is no independent information on the level of secondary control taking place on these properties (Johnson, pers. comm.), however farmer comments indicate that, as in other areas, control efforts reduced or ceased after the arrival of RHD. After the major aerial poisoning programmes (using pindone) that were required to bring rabbit populations back down to acceptable levels (Figures 18, 19 & 21), two properties have increased their secondary control measures by jointly employing a rabbiter (Satterthwaite, pers. comm.).

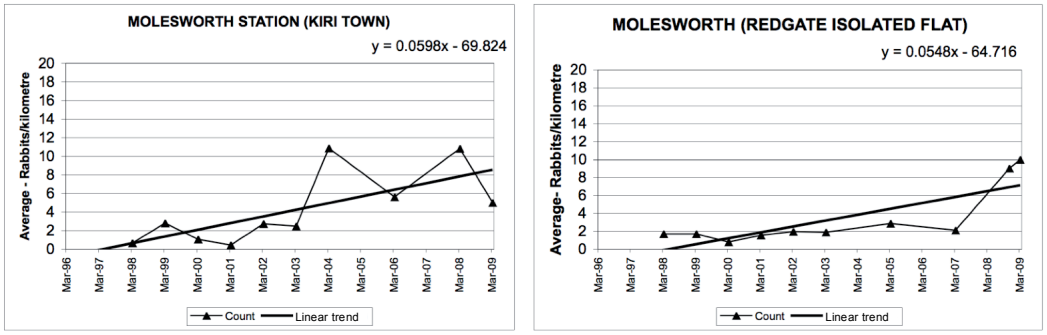
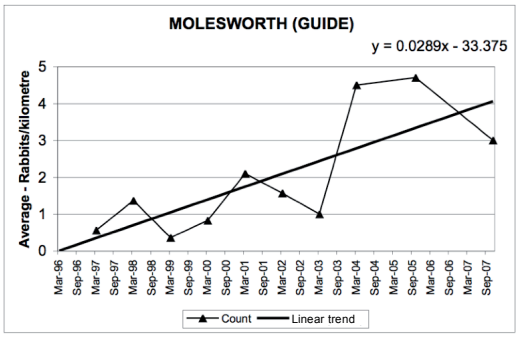


Figure 13 & Figure 14: Rabbit population trends at Molesworth Station

(Source: Marlborough District Council)



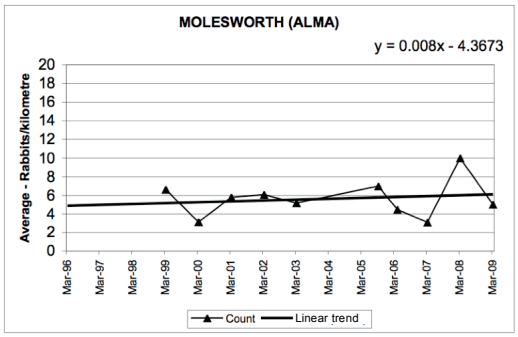
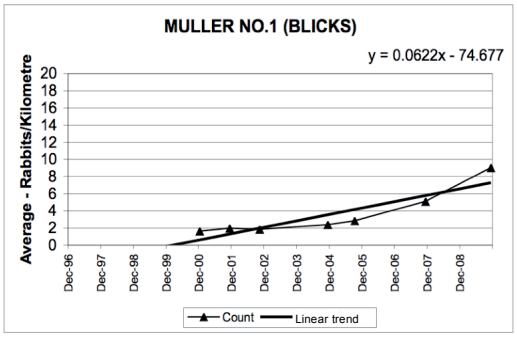


Figure 15 & Figure 16: Rabbit population trends at two more Molesworth sites
(Source: Marlborough District Council)



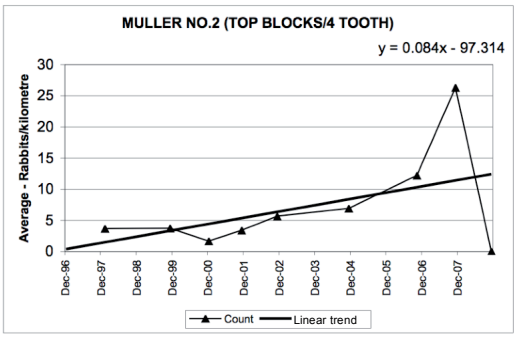
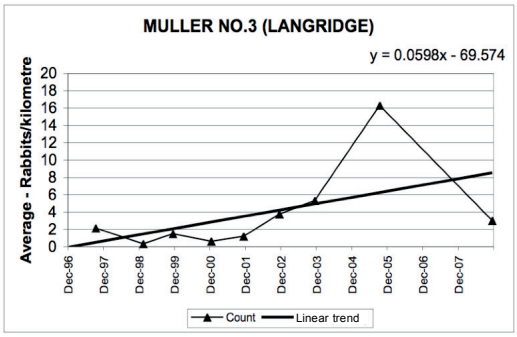


Figure 17 & Figure 18: Rabbit population trends at Muller Station – Awatere Valley
(Source: Marlborough District Council)



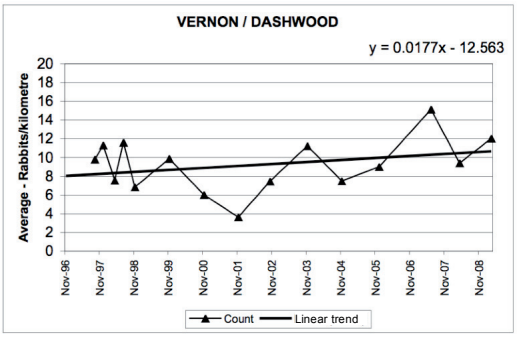
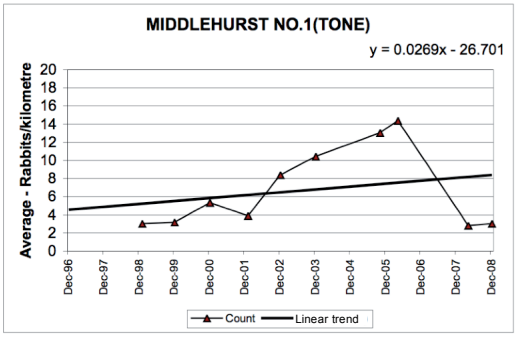


Figure 19 & Figure 20: Rabbit population trends at Muller and Vernon/Dashwood
(Source: Marlborough District Council)



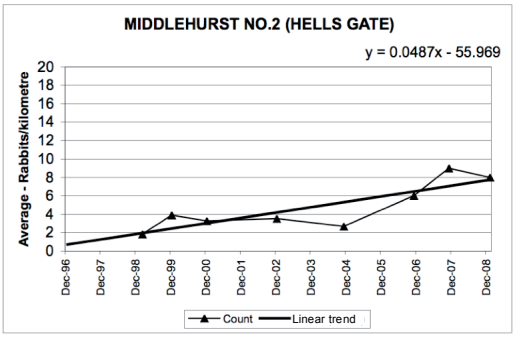


Figure 21 & Figure 22: Rabbit population trends at Middlehurst – Awatere Valley
(Source: Marlborough District Council)

8.1.6. Rabbit Ground Sign Monitoring

Night-counting is the principal method used by councils to monitor trends in rabbit populations. However, the 'modified' McLean Scale (MMS), which looks at ground sign, is used by all regions to assess compliance with the Maximum Allowable Limits (MAL) in their Regional Pest Management Strategies.

Table 2 shows the Modified McLean Scale with the field descriptions that enable assessors to assign the appropriate value to an area of land. This scale provides an index of rabbit density based on the amount of fresh rabbit faecal pellets present on the ground and the numbers of rabbits seen. If the whole property or management area is to be assessed, the different habitats within it must be sampled to ensure that all habitats are adequately represented in the survey.

A description of the parameters used to assess each level of the Modified McLean Scale allows landholders to estimate their own rabbit levels. Assessing the amount of faecal pellets and the distances between the pellet heaps is reasonably straightforward but determining what is 'fresh' or 'old' sign can be difficult. Experienced assessors will pick up more evidence of rabbit grazing pressure, territory markings and scratchings etc.

Table 2: Modified McLean Scale

1	No sign. No rabbits seen.
2	Very infrequent sign seen. Unlikely to see rabbits.
3	Sign infrequent with (buck) heaps more than 10 metres apart. Odd rabbit may be seen.
4	Sign frequent with some heaps more than 5 metres apart. Groups of rabbits may be seen.
5	Sign very frequent with heaps less than 5 metres apart in pockets. Rabbits spreading.
6	Sign very frequent with heaps often less than 5 metres apart over the whole area. Rabbits may be seen over the whole area.
7	Sign very frequent with 2-3 heaps often less than 5 metres apart over the whole area. Rabbits may be seen in large numbers over the whole area.
8	Sign very frequent with 3 or more heaps often less than 5 metres apart over the whole area. Rabbits likely to be seen in large numbers over the whole area.

After a recent population decline (for example after control work or an RHD epizootic), it can more difficult to assess rabbit density because the sign and pellets reflect the previous higher population. Some councils carry out routine inspections every year while others confine their inspections to any land known to have, or suspected of having, high

rabbit numbers. Criteria such as the rabbit proneness of the land and rabbit management practices are also used when selecting properties to inspect.

By collating the information gained from ground inspection surveys using the MMS, councils can determine the area of land within their region that exceeds the allowable rabbit population densities. All land is subject to these inspections, including Crown land; any breaches on public land are reflected in the total for each region.

Annual assessments of rabbit densities over a property provide a regular check on the rabbit status. The results can provide accurate trigger levels for control, an integral part of property pest management plans. This information is crucial if rabbits are to be effectively maintained at densities below their MAL. Ecological values are generally unlikely to be at significant risk when rabbit population densities are below the MALs set by councils.

A few regions use the MMS to assess long-term rabbit trends, but usually in conjunction with night-counts (e.g. Environment Southland). The MMS can be used for determining the effectiveness of control operations but night-counts provide a more robust, albeit more expensive, method.

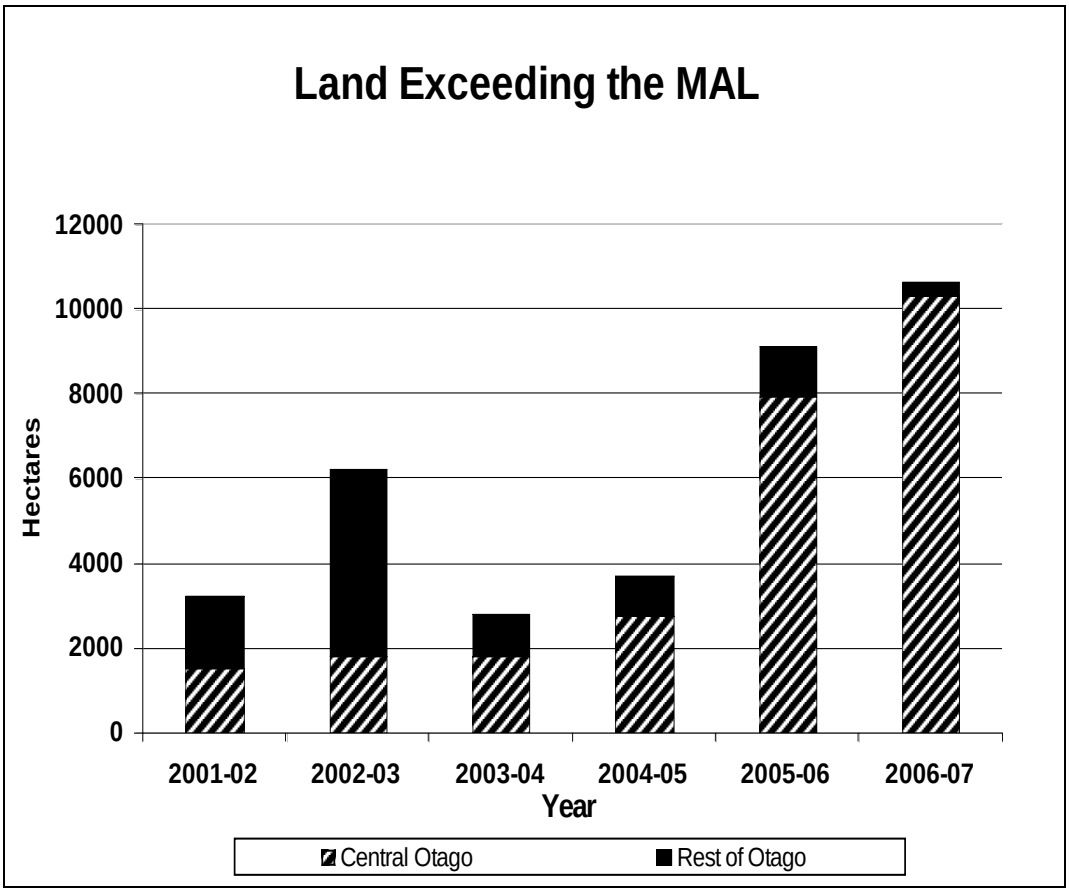


Figure 23: Trends in land exceeding the maximum allowable limit – Otago
(Source: Otago Regional Council)

As with the other regions with semi-arid lands, there has been a trend to an increasing amount of land in breach in Otago, as seen in Figure 23. This gives an indication of where the rabbit problem lies for Otago. Similar increasing amounts of land in breach have been recorded for Canterbury and Marlborough as shown in Table 3.

Table 3: Areas of land exceeding MAL in Canterbury, Marlborough and Otago

	Canterbury		Marlborough		Otago	
	Total area (ha)	Range (ha)	Total area (ha)	Range (ha)	Total area (ha)	Range (ha)
2006/7	0 (since 1997)	0	0		10,600	1 - 700
2007/8	26,000				12,000 (approx)	
2008/9	20,000	2 - 3,000	13,300	5 - 3,000	14,000 (approx)	
2009/10	8,000	5 - 4,000	21,300	64 - 3,262	50,000*	

* Estimate only - the recent change in the MAL from 5 to 3 for about 115,000 ha in the SAL explains the large increase in Otago

Primary poisoning costs

The costs for poisoning vary from round $50/ha through to nearly $100/ha depending on the area involved, how it is laid, rates of bait application, remoteness etc. (see Appendix one). Table 4 provides some examples of Otago properties faced with primary poisoning in 2009. The number of stock units relative to the area poisoned gives some indication of the financial impact of an operation, and the proportion of a property being treated indicates the potential disruption associated with de-stocking the area until stock can safely graze again.

Table 4: Examples of 2009 primary poisoning programmes

	Area poisoned (ha)	Area of property (ha)	Stock units
2007			
Property 1 Marlborough	3,260	53,500	
Property 2 Marlborough	2,550	16,250	
2009			
Property 3 Otago	320	3600	9500
Property 4 Otago	460	2100	7000
Property 5 Otago	440	1930	11,000
Property 6 Canterbury	3,000	9,000	9,500
Property 7 Canterbury	3,200	8,000	11,500
Property 8 Canterbury	1,400	22,100	28,000

8.1.7. Rabbit population trends in other Regions of New Zealand

Information gained from other councils in New Zealand indicates that rabbits are currently not a significant problem there for pastoral or horticultural production or the environment. This is not to say that rabbits do not cause damage elsewhere, it means the level of damage does not warrant intervention at more than a local or minor scale. Data from Southland showed rabbits at levels below 1.5 per km and trending downwards (average 1.13). This suggests that rabbits are not likely to increase there in the foreseeable future. Rabbit levels were generally low and stable in the Taranaki, Manawatu and Wellington regions. There are still low levels in the Hawkes Bay despite an increase in 2007 to an average of 4.4 rabbits per km. These pockets of increasing rabbits were easily controlled and numbers were down to 3.3 per km at the last counts (see Figure 24).

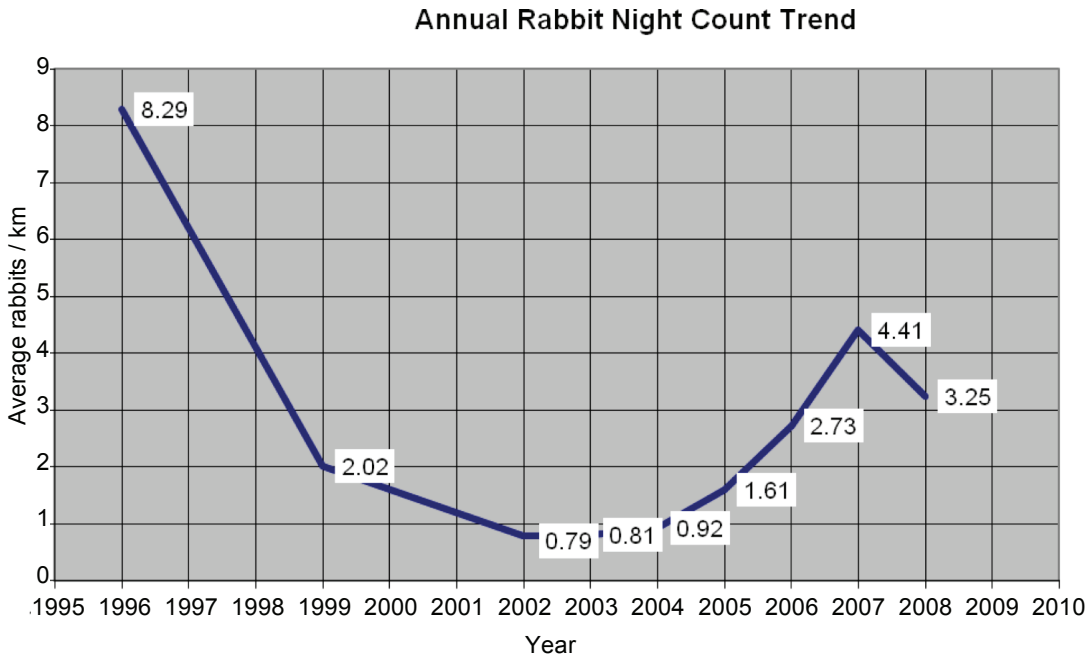


Figure 24: Rabbit population trends in Hawkes Bay

(Source: Hawkes Bay Regional Council)

The absence of any identified significant rabbit problems in areas outside the semi-arid lands of the South Island high country is consistent with the data collected during the establishment of the RLMP. For that reason this report has focused on the information available from the Marlborough District Council and the regional councils of Canterbury (ECAN) and Otago.

8.1.8. Discussion

Rabbit populations have been increasing since the initial knockdowns following the introduction of RHD; recently some have increased to concerning levels. More farmers are undertaking some rabbit control, but often the control is too little or the control techniques are miss-matched to the level of rabbit infestation; The night-count data from Marlborough shows some dramatic increases in rabbit numbers, with populations increasing five-fold in a few years and, in another case, they more than doubled between annual counts.

The Otago monitoring data shows that numbers were relatively stable between 2006 and 2007, with a small increase in 2008; the 2009 results are expected to show a further small overall increase.

While the most rabbit prone land in Canterbury (Mackenzie Basin) is showing an increasing trend in rabbit numbers, the rate and magnitude of the increase on monitored properties are less than recorded in Marlborough. However, the rising rabbit population '*has meant that increasing rabbit control effort has been required from landholders at considerable cost to them in order to try and contain the increase. The fact that containment has not always been achieved or that containment has been at levels above the local RPMS is reflected in the increasing number of Work Required Notices being issued by local authorities. Most times the only effective control option to meet the work notice requirements is the use of poisoning, usually on a large scale.* (Canterbury Regional Rabbit Trends, 2008).

It is vitally important that technical standards of any poison operations are maintained at the highest level to avoid rabbit populations becoming exceedingly hard to keep under control because of bait and/or poison shyness. An unfavourable economic environment for farming could compound this problem.

Without ongoing and well-executed secondary control on the most rabbit prone semi-arid lands, more and more properties will find that their rabbit populations increase to levels that require large scale poisoning. However, the Regional Pest Management Strategies of these regions have established enforceable maximum allowable rabbit densities to ensure that unacceptable population increases do not occur.

9. Maintaining the benefits of RHD on rabbit prone land

9.1. *Secondary control*

RHD is still effective and making a difference but adequate secondary control measures will always be necessary to take advantage of RHD on rabbit prone land - killing the survivors before they breed and limiting the potential for viral attenuation and evolutionary adaptation in rabbits (refer to section 10). The RCD Applicant Group made it clear that ongoing rabbit control with conventional control tools would still be required on rabbit prone land if RHDV were to be introduced (refer to section 7) and regional councils have reinforced this message since its arrival. When considering the implications of RHD immunity for rabbit management, the key factor is not the proportion of immune survivors, but the number of immune survivors, especially females (Lough, 1998). When epidemics do not achieve good kills and a high proportion of the survivors are immune, it is particularly important to target residual populations with other control measures.

The 1970's and 80's saw rabbits reaching problem levels over most of the semi-arid lands, not seen since before the introduction of 1080 in the early 1950's. Some of the highest numbers were seen in the Alexandra District where rabbits had transformed large areas of pastoral land into bare ground or degraded the vegetation to the extent that the only plant species remaining were those unpalatable to rabbits, such as scabweed and stonecrop.

The most publicised property in the Alexandra District was the 25,000-hectare Earnscleugh Station, which regularly featured in the media to show the 'hillsides moving with rabbits'. Approximately 14,000 of the 18,000 hectares of rabbit prone land on this property are recognised as high (20%) or extreme (80%) in rabbit proneness. From 1956,

up to 80 percent of the cost of rabbit control on this property was met by public funding (Campbell pers. comm.). During the 1980s, large inputs continued to be directed to rabbit control together with the landholder's own Pest Destruction Board rates of more than $1 per hectare for the worst affected land (1988 dollar value). However problems of poison and bait shyness resulting from a history of frequent poisoning, and the sheer scale of the problem, meant that no headway was being made.

The injection of substantial public funding through the RLMP enabled Earnscleugh to reduce rabbit populations to very low levels. Internal and boundary rabbit proof fencing was erected to create manageable blocks and boundaries for control. The control effort focussed initially on the higher less rabbit prone country and then moved progressively downhill. However bait and poison shyness in the rabbit population meant that kills of only 70 percent were being achieved (c.f. up to 98 percent on other properties) leaving the seemingly insurmountable task of killing the survivors and their offspring by other means.

The runholder has no doubt that the turning point came when '*we took ownership of the operation ourselves*'; in the days of the rabbit boards it had always been 'someone else's problem'. Two skilled staff were hired and rabbit control became (and continues to be) the first priority in all business decisions *'because we knew that rabbits were the only thing that could wipe us out'* (Campbell, per comm.). After a concerted effort, much of it on very difficult terrain, rabbit populations suddenly declined over a period of a few months (possibly enhanced as the predators present had an increasing impact on the declining population). **This was achieved prior to the arrival of RHD.**

Figure 25: Earnscleugh land subject to secondary rabbit control measures

Good farm management practices were in operation, such as keeping stock off land recently cleared of rabbits, so that a seed bank could again build up over a number of years. Rabbit habitat was successfully modified by prolonged spelling from grazing of the worst areas; this increased the vegetation cover and enhanced predator success. As the sward of vegetation increased so did the incidence of coccidiosis, a disease of the liver that can cause high mortality in young rabbits when they are exposed to a thick wet sward. Briar and scrub was removed to make areas less favourable to rabbits and the reduced cover made shooting more effective.

Commitment to secondary control measures after the RLMP maintained rabbit populations on Earnscleugh at very low levels and the property recovered, with dramatic improvements in vegetation and ground cover. Blocks that had been unable to carry stock for 10 years began to contribute to farm income.

The advent of RHD provided further assistance in maintaining the low rabbit levels that had already been achieved. Earnscleugh has continued to employ one fulltime skilled rabbiter. The predominant secondary techniques used are night-shooting (70%), day shooting with dogs, and some helicopter shooting. No poison programmes have been necessary since 1995. Maintenance of rabbit proof boundary fences has been essential to prevent re-infestation from the many neighbouring smallholdings and lifestyle blocks. A recent incursion led to a concerted effort being required to bring the resulting local infestation under control (Campbell, pers. comm.).

Most of the approximately 18,000 hectares of rabbit prone land on Earnscleugh are of high and extreme proneness. The fact that rabbit populations have been maintained at the low levels that were achieved before the arrival of RHD in 1997, using existing secondary technologies, demonstrates that rabbit control can be viable in the post-RHD environment. Annual expenditure on rabbit control has been stable since 1997 at about $3 per stock unit.

Earnscleugh is not the only extremely rabbit prone property in the district demonstrating that rabbit control is achievable and financially viable - Galloway, Matangi, Little Valley and Kawerau are other examples of stations rated as extremely rabbit prone and all are currently maintaining rabbits at low levels. As stated earlier, most of the Otago RLMP properties of extreme rabbit proneness have kept rabbit populations well under control for at least 12 years. These Otago properties are considered to be among the most rabbit prone in NZ.

The Otago and Canterbury Regional Councils and the Marlborough District Council have all advised that they are not aware of any properties, under similar levels of control to Earnscleugh, on which rabbit populations have got out of hand.

On the 11,600-hectare Galloway station, approximately 10,000 hectares are classified as moderately to extremely rabbit prone. The property carries 10,000 stock units. Rabbit populations are being maintained at negligible levels and this can be seen on the Otago Regional Council RHD Upper Manorburn site depicted in Figure 9. The whole property requires rabbit control and this equates to annual expenditure of $70,000, including helicopter time.

Before the arrival of RHDV on a 10,000-hectare station of 5,000 stock units in the Mackenzie Basin, rabbit populations were rising (as on many other properties) despite secondary rabbit control expenditure of $10 to $12 per stock unit. The station is now (post RHD) maintaining rabbit populations at low levels with expenditure of between $2 and $4

per stock unit - predominantly by night-shooting with some patch poisoning (Simpson, pers. comm.).

For the last eight years, another rabbit prone Mackenzie station has employed a skilled part-time rabbiter. His monthly day and night-shooting has helped maintain rabbit populations at low levels (Fastier, pers. comm.). Day shooting is matched to the terrain – some hill slopes in the morning sun, others in late afternoon. All night-shooting takes place when there is no visible moon. Again, in the three years prior to the arrival of RHD, an immense commitment to secondary control was failing to hold a rising rabbit population on this farm.

Helicopter shooting has been in use for nearly 20 years and its use is increasing, especially in less accessible terrain. At about $11 per hectare, it is considered to be cost effective when preventing or delaying poisoning costs of up to $100 per hectare. Maniototo Pest Management Ltd has recently begun to use this technique on the more rugged hill country over which they carry out control (see section 15.1). It is essential that the pilot and hunter are both skilled and experienced in working together as a team.

Secondary control methods are most effective when used under the correct conditions by experienced staff. The most common cause of problems is when a method is used where rabbit numbers are too high or where the terrain is not suitable. For example, a shooting programme should not occur when rabbits have been allowed to reach too high a level.

In the examples given above, an ongoing commitment to rabbit control has been essential to the successful suppression of rabbit populations in the post-RHD environment, managed within the farming business and without the need for public funds. Another important factor has been the employment of mature, motivated, skilled and methodical rabbit control staff; there is some concern in the farming community about the availability of such skilled people in the future.

9.2. *Key factors for success*

There are common factors among landholders who have maintained low rabbit populations since the arrival of RHD:

- They accept responsibility for rabbits
- They are well-informed
- Rabbit management is an integral part of the business as a whole
- There is an annual financial commitment to secondary control
- Vigilance
- The use of skilled and committed staff
- The control methods applied are appropriate for the terrain and rabbit population densities.

... opportunity should be taken to learn from farmers prepared to share their experience in effective management of rabbit prone land.

9.3. *Some concerns*

There has been influential hypothesis, but unproven, that a commitment to ongoing annual expenditure on secondary control measures to target survivors of RHD may be a waste of money or more expensive than cyclic primary poisonings or a combination of secondary and primary control measures.

'After the promising first few years of RHD, many held off re-introducing control work. They were afraid that after spending money on secondary work the virus would reappear and would have killed those rabbits at no cost. Many also held off control after publicised statements that a good base population might be required to get the greatest benefits from the virus. It was reported that these rabbit levels might allow the virus to spread throughout the population and this base population provided a source of epidemics as immune adult rabbits harboured the virus in their liver ready to be activated when conditions were favourable. Such advice was in conflict with council staff advice that keeping rabbits at low levels and the removal of immune rabbits were highly desirable.'

(Robson, former Otago Regional Council technical advisor)

Post RHD, some properties, especially on less rabbit prone land, may get by with no rabbit control for a time (such as the Otago lowland and coastal properties shown in Figure 7), but where and under what conditions is most uncertain. Today, for those on high and extreme prone land, heeding the advice to 'do nothing' carries the severe risk of losing control and could put some farmers out of business (Campbell, pers. comm.). Furthermore, allowing surviving rabbits to remain and breed could reduce the benefits of RHD for all landholders by increasing the potential for viral attenuation and genetic resistance (refer to section 10).

There was a high level of awareness among farmers of secondary control techniques by the end of the Rabbit and Land Management Programme (see section 16). Yet the councils in Otago, Canterbury and Marlborough and several farmers have expressed deep concern at the inadequate level of ongoing secondary control on some properties and consider that this is strongly linked to the increasing rabbit populations there.

Either many of the farmers now facing major primary poisonings did not notice obvious warning signs that their rabbit populations were about to 'explode' beyond the reach of cheaper secondary control measures or the warning signs were not obvious. The latter is much more likely, especially given how little is known about RHD epidemiology and the poorer sensitivity of rabbit density assessments at low to moderate population levels. In 1994, the Working Party on Sustainable Land Management highlighted the need for a predictive capability for rabbit population explosions; meeting this need became much harder with the arrival of RHD (refer to section 10.4). However some landholders have learned to manage the risks associated with rabbits, despite the unknowns.

9.4. *Primary poisoning*

Most landholders are now using secondary methods, usually shooting, in preference to major primary poison operations. Others use aerial or ground poisoning as their main method and this can be successful, but can also be expensive. As long as poisoning programmes are well planned, of a high technical standard and leave sufficient time between poisonings, the risk that rabbits will become bait or poison shy can be minimised. Kills of up to 99% can be obtained. The choice to use primary poisoning is often dictated by the accessibility of the land for effective ground shooting. The rabbit levels at which poisoning occurs are normally below the threshold where pastoral or ecological values are threatened (this also applies to Otago now that the MAL is 3). A typical sequence in a poisoning regime has been a poison followed by night or helicopter shooting for the next two or three years to remove any bait or poison shy survivors and slow down the post-poison rabbit recovery rate. The shooting effort is then switched to other blocks that have since been poisoned. After a further two years the original block is poisoned again and the cycle continues.

Evidence has been received about several instances of poorly planned and poorly executed 1080 primary poison operations involving poor kills and/or inadequate follow-up measures. For the landholder, the consequences of such failures can be severe – another expensive primary could be required in 2 or 3 years and this heightens the risk of surviving rabbits developing bait and/or poison shyness. The resulting failures could compound the problem by further shortening the poisoning interval to a point where the rabbit population is almost beyond control and certainly beyond the financial means of landholders.

It took nearly $3 million dollars to regain control over the bait and poison shy rabbit populations that developed on Earnscleugh during the final years of the Pest Destruction Board regime (see comments in section 9.1).

An increased reliance on 1080 (and pindone) to bring rabbit populations back under control would be very concerning, and even more so if poor planning and/or technical standards were associated with their delivery. It has long been recognised that these tools may not always be an available option, even when applied correctly. They may become:

- socially unacceptable in New Zealand and in its overseas markets (Working party on Sustainable Management, 1994);
- financially unsustainable; or
- technically incapable of regaining control of bait and/or poison shy rabbit populations that are beyond the reach of secondary control measures.

It is therefore essential to ensure high technical standards and highly desirable to use other control measures to extend poison intervals as far as possible or negate the need for primary poisoning at all.

Recommendation

Councils must act with some urgency to seek regulations, standards or mandatory codes of practice for poisoning programmes to ensure that future rabbit management is not compromised.

9.5. *Rabbit-proof fences*

The RLMP saw hundreds of kilometres of high standard rabbit proof fencing erected or upgraded on many of the 115 properties involved. These fences have enhanced the effectiveness of rabbit control by providing boundaries for management and by limiting re-infestation from neighbouring land; ongoing maintenance is essential. After the arrival of RHDV in 1997, the bottom netting on many of these fences was lifted above the ground in the belief that this would enhance the spread of the virus, but they have since been reinstated (Robson, pers. comm.).

9.6. *Changes in habitat*

The RLMP encouraged and funded habitat modification to make land less favourable to rabbits on participating properties. Large areas of scrub/briar were removed mechanically or sprayed and this has provided some long-term benefits for rabbit management (but losses for conservation in some instances). Since then, deliberate modification of habitat for rabbit management has been uncommon, but it has often been the by-product of land use change.

Spelling of land from grazing, in conjunction with good rabbit control, can allow cover to increase to the extent that rabbits are forced onto smaller patches of more favourable habitat where they can be more easily targeted for control (Campbell, pers. comm.).

Conversion of pastoral land to dairying has made land in Southland much less favourable to rabbits and the increasing development of dairying in the Mackenzie Basin will have a similar effect. The Amuri Basin in Canterbury is another example of land use rationalisation to dairying that has markedly altered the habitat for rabbits. In Central Otago, the establishment of vineyards with a high per hectare earning potential has made rabbit control much more affordable, while at the same time changing the landscape to a less favourable habitat. Some of the most rabbit prone land along the dry foothills in Central Otago is the most suitable for grapes. Many of the terraces of the Awatere Valley in Marlborough are now planted in grapes. Overall however, the physical scale of land use/habitat change in the semi-arid rabbit prone lands is relatively small.

9.7. *Enforcement*

The Regional Pest Management Strategies in Southland, Otago, and Canterbury set the maximum allowable limits of rabbit density at 3 on the Modified McLean Scale; in the Upper Awatere Valley of Marlborough the limit is MMS 4; in the rest of the region it is MMS 3. Some regional councils carry out routine inspections each year while others confine their inspections to land known to have, or suspected of having high rabbit numbers.

When properties are found to have rabbits exceeding the MAL, discussions with the landholder are undertaken to inform them of the findings, remind them of their RPMS obligations, determine what their control plans are for the area in breach and to provide advice on a suitable approach to regaining control of the population. Councils offer assistance in developing ongoing pest control programmes as well as advising landholders of the options they have in regards to control methods and their costs. Federated Farmers supports council compliance monitoring (Ward, pers. comm.).

In addition to providing benefits to production values and limiting offsite impacts, Regional Pest Management Strategies for rabbit control are also intended to protect environmental values such as soil, water and conservation values.

- The prevention of land degradation and spillover are benefits given in justification of the Otago RPMS.
- In Canterbury, the ‘protection of conservation values’ is noted as a benefit; others are the protection of economic benefits for rural landowners and the prevention of spillover to neighbouring properties.
- In Marlborough, the RPMS lists ‘conservation values’ as a major beneficiary in addition to production benefits.

The potential for rabbits to threaten such environmental values is far lower and may be negligible when rabbit population densities are below the maximum allowable densities of MMS 3 or MMS 4 of Regional Pest Management Strategies. At levels well above these MALs, rabbits can have severe direct impacts on soils and vegetation and indirect impacts on fauna through habitat modification and rabbit predator by-catch. Therefore RPMS enforcement provisions do help to ensure the protection of environmental values as well as protecting production values and limiting offsite impacts.

Although the RPMS require landholders to meet the full costs of rabbit control, the regional benefits are acknowledged through contributions by general ratepayers towards some or all of the associated costs of inspections, compliance, trend monitoring, education, advice and RHD serology (refer to section 13).

Should a landholder not comply with an approved control programme, the councils issue a Notice of Direction or a Notice of Required Work stating what the landholder is required to do and the time in which it must be achieved. If this is not complied with, the council will issue an Enforcement Notice or Notice of Intention to do Work on Default, advising that council staff or a contractor will do the work, with all costs being met by the owner.

Until 2008, approximately 115,000 ha of land in Central Otago had a MAL of MMS 5. This level meant rabbit populations could greatly exceed the permitted level within one breeding season. The MAL has now been reduced to MMS 3, which ensures that adequate time is available to undertake control work before the population 'explodes'. If a landholder refuses or is unable to co-operate, there is sufficient lead-time to enable councils to make arrangements in time for the necessary winter poisoning.

Secondary control measures are sufficient to reduce rabbit populations from a level of MMS 3. However councils have advised that at MMS 4 secondary control may be ineffective in large areas or on difficult terrain. It may be in the best interests of landholders in those parts of Marlborough under a maximum limit of MMS 4 to take this into account when planning their rabbit management strategies.

All three councils have recorded increases in the number of notices of work required and a corresponding increase in the total land area in breach of their RPMS. For the 2009/2010 season, land exceeding the maximum allowable limits is expected to be approximately 8,000 hectares in Canterbury, 23,300 hectares in Marlborough and 50,000 hectares in Otago. Only a portion of these properties are expected to receive Notices of Direction but many will be following approved control programmes.

With the reduction in the MAL from MMS 5 to MMS 3 in Otago, occupiers with rabbit densities exceeding MMS 3 must '*have an approved control programme to ensure a reduction in combined rabbit and hare infestation to a level of 3 or less*' over a transitional period of several years (Otago Regional Pest Management Strategy, 2009).

Councils acknowledge the financial burden that large poison operations can impose on a landholder and on a case-by-case basis have allowed deferred payments, in which case a lien on the farm title is usually required.

10. Research considerations

'Effective quality research on questions of sustainability requires an informed, coordinated, collaborative, inter-disciplinary approach with top research capability. Research methodologies need careful selection and the appropriate streams of research endeavour and skill must be logically and coherently planned and then executed in a manner which will give both certainty and relevance to the conclusions.'
(Working Party for sustainable land management,1994).

10.1. *Assessing the prevalence of immunity to RHD*

In 1996, a benign calicivirus of rabbits was identified by Capucci et al (OIE Reference Laboratory in Italy) and given the name *rabbit calicivirus*. Capucci found that naïve rabbits challenged with *rabbit calicivirus* survived infection and became immune to the virulent

rabbit haemorrhagic disease (Capucci et, al. 1996). Other apparently benign strains of RHDV have since been reported (Forester et al, 2007).

Accordingly, the RCD Applicant Group conducted an extensive serological survey of feral rabbits obtained from the main rabbit-affected regions of New Zealand to test for pre-existing antibodies to RHDV (Lough, 2000). Sera obtained from healthy live rabbits were tested by a number of assays, including the competitive ELISA (cELISA) developed at the OIE-RL (Capucci et. al. 1996) which uses RHDV monoclonal antibodies (Mabs) as the primary means for detecting serum antibodies. Other assays used were the Sandwich Indirect ELISA (inELISA), the Solid Phase ELISA (sp ELISA) and the Competition ELISA using a degraded form of RHDV (cdELISA).

Although only low to medium antibody levels were found using the cELISA, most at titres of 1:10, the combined results of all assays indicated that the putative infectious agent might be a non-pathogenic calicivirus (Capucci, 1997). However, from the high mortality in feral rabbits following the arrival RHDV in New Zealand in 1997, it seemed that the pre-RHD antibodies were not significantly protective to RHD. Where the disease had spread naturally, monitored Otago populations had dropped by 40 to 90 percent. It was therefore recommended that the serological testing conducted by the Central Animal Health Laboratory in New Zealand (which used the cELISA) should be conducted at dilutions between 1:40 and 1:160 to determine what proportion of a rabbit population had immunity to RHDV (O'Keefe et al, 1998). However, it should always be remembered that the Capucci ELISA cannot clearly differentiate between exposure to non-pathogenic calicivirus, exposure to RHDV by infection or exposure to RHDV passively.

The strain of RHDV introduced to New Zealand was closely related to the Czech strain, yet RT-PCR sequencing in the United Kingdom, from freeze-dried livers of apparently healthy feral rabbits from New Zealand, detected a sequence from one rabbit more closely related to the virulent Spanish strain (Forrester et al, 2003); contamination in the laboratory was thought to be unlikely. The study was not capable of determining whether or not this was the putative benign New Zealand calicivirus.

The cELISA is still used in New Zealand to determine what proportions of rabbit populations are seropositive (the presence of antibodies to RHDV) and it has become common practice to assume that the proportion seropositive equates to the proportion immune to RHD. Regional councils report percentage immunity in their annual monitoring, researchers use it when making statements on RHD epidemiology (Parkes et al, 2008) and farmers discuss the percentage immunity in rabbit populations on their properties.

Studies indicate that RHDV antibodies measured by cELISA do not always protect against infection (Marchandeau et al, 2005) (Forrester et al, 2007). After RHDV challenge trials with wild rabbits in Australia, Butler and McPhee (2002) concluded that caution was required in the use of the cELISA to determine the prevalence of immunity to RHD.

In New Zealand it has been reported that seronegative rabbits (cELISA) are not necessarily susceptible to RHD. Parkes et al (2000) dosed 13 seronegative rabbits taken from Northland before RHDV arrived there. All 13 of the apparently susceptible rabbits survived inoculation with RHDV to become seropositive; the researchers concluded that they were immune (although the experiment appears to have lacked controls, replication or the isolation of rabbits from 'wild' sources of live or inactive virus). They also reached the conclusion that rabbits lost antibodies over time to become seronegative, (i.e. not detectable with the cELISA) but still immune.

Other factors may confound these interpretations, for example the ingestion of live or degraded virus from baits, rabbit faeces or fly spots on pasture (Atkinson, pers. comm.). The role that cell-mediated immunity (Huang, 1991 cited in Lough, 1998) plays in response to RHDV is still being investigated overseas (Farnos et al, 2006).

The serum antibody reacting to the cELISA, while an indicator of viral challenge, may not be the protective neutralising antibody. Thouvenin et al (1997) reported a very specific neutralising antibody, a monoclonal antibody, and found that it needed a specific virus-like 3D structure to be effective and presumably would have to be elicited the same way. If this were the case, VP60 capsid protein antigen by itself (e.g. from degraded virus or even non-neutralising epitopes on live virus) would not necessarily produce a neutralising response (Atkinson, pers. comm.). There is very little in the literature on RHDV neutralising antibodies in general and it may be useful research to understand the relationship between ELISA reacting serum antibody and neutralising antibody in the New Zealand RHDV strains. The currently used cELISA in NZ does usefully indicate the presence of RHDV in a population and so the distinction of neutralising antibodies might not have necessarily mattered. However, the recent publication of studies showing heritable differences in susceptibility to infection (Guillon et al 2009) allows a more informed interpretation as to the reason for seropositive survivors. These studies showed a particular blood group type could not provide the necessary viral receptor for infection, and presumably an RHDV epizootic would cause growth of such subpopulations resistant to infection. Unfortunately the study presented no immunological data on survivors. It would therefore be useful to have a simple assay to measure such survivors and having the current cELISA using a neutralising Mab might allow adaptation of the assay to make such measurements (Atkinson, pers. comm.).

The Animal Health Laboratory Team at the Wallaceville Investigation and Diagnostic Centre has the immunology expertise to advise initially on the need, scope and potential for refining the cELISA (O'Keefe, pers. comm.) and could be asked to provide oversight for, or undertake, any consequent research project, perhaps working collaboratively with a Crown Research Institute or University and skilled council pest advisors.

Until an assay more specific to the RHDV neutralising antibody is available, it is unwise to assume that a rabbit population's level of immunity equates to the proportion seropositive to the cELISA. The proportion immune could be higher, and it could be lower. These uncertainties, together with the presence of benign strain(s), make epidemiological predictions based on the cELISA unreliable and in any event does not abrogate the necessity of shooting or otherwise eliminating as many survivors as possible for the RHDV epizootic to remain effective.

Recommendation

Investigation by the Wallaceville Investigation and Diagnostic Centre to better determine the need and potential for refining the cELISA assay.

10.2. *Persistence of virus in survivors of viral challenge*

There has been some suggestion that rabbits which have survived RHD may remain a source of infective virus (Parkes, 2000). Some farmers believe that it might therefore be advisable not to undertake secondary control to kill them. A search of the literature revealed no studies to support this advice. To the contrary, the study of Guillon et al just discussed shows such a course would only encourage growing viral-resistant populations. Such resistant populations might even show seroconversion but could not be

the source of infectious virus. Without a sound and tested epidemiological model, such advice could result in very significant risk to the effective management of rabbit prone land.

Forrester et al (2003) found RHDV-specific RNA in the livers of apparently healthy wild rabbits sourced from Otago and suggested that these healthy rabbits might have persistent or latent infections and the potential to be infectious. However, no serology was undertaken to determine the antibody status of the rabbits, their age was not assessed, and the possibility of ongoing ingestion of RHDV was not ruled out. The authors acknowledged that the livers of young rabbits challenged during the period of non-resistance or with residual maternal antibody may have yielded the RHDV-specific RNA. They were unable to demonstrate infectivity or an immune response when inoculating a naïve laboratory rabbit with liver (albeit freeze-dried) suspensions from these animals.

Gall et al (2006) demonstrated the persistence of RHDV-specific RNA for up to 15 weeks in the organs of convalescent seropositive rabbits which were overcoming experimental infection with RHDV. They too were unable to demonstrate infectivity or seroconversion when inoculating a susceptible animal with this material.

Neither of these studies was able to demonstrate that rabbits, which survive RHD, remain a source of infection to susceptible rabbits. In any event, would such a scenario justify no secondary control on highly rabbit prone land?

- First, there is very good evidence that after its arrival in 1997, as in many other countries, without human assistance, RHDV spread rapidly throughout rabbit populations of both high and low density, none of which contained a reservoir of 'infective' rabbits. Furthermore, serological monitoring in Otago and Canterbury shows that RHDV is still active in low density populations, including those held at very low levels by implementation of ongoing secondary control measures.
- Secondary control to kill survivors of RHD will hinder the evolution of less virulent strains.
- Rabbits younger than 10 to 12 weeks are likely to survive RHD, become immune for life and breed.
- It is not known whether the heavy selection pressure from RHD in New Zealand's rabbit prone regions might extend the period within which young rabbits are not fully susceptible to the disease. However, eliminating RHD survivors will reduce the potential for this to occur.
- On highly rabbit prone land, the practice of allowing too many survivors of RHD to remain has resulted in exponential rabbit population increases on numerous properties in Otago, Canterbury and Marlborough. This has necessitated expensive broad scale primary poisoning programmes, using 1080 or pindone. Yet, on other land of high and extreme proneness, populations have remained at low and stable levels under a regime of ongoing effective secondary control (refer to Otago Regional Council monitoring data, 1997 – 2008.)

Taken together, these points suggest that establishing the latent infectivity of survivors of RHD is not an immediate priority for research in New Zealand. The work on blood group susceptibility to RHDV of rabbits (Guillon et al, 2009) reveals a fundamental virological mechanism that will also be at work in NZ and which probably explains the presence of most of the survivors – seropositive or not.

10.3. *The line between naturally stable and unstable rabbit populations*

Prior, to the arrival of RHDV in New Zealand, rabbit populations in areas of negligible to low rabbit proneness were held at low and relatively stable levels by natural factors such as predation, drowning, coccidiosis and unfavourable habitat. RHD is an addition to this suite of natural factors and may have changed the proneness threshold above which active measures are required to control rabbit populations to acceptable levels. It is to be hoped that it has risen and that more land is now in the 'naturally stable, no-control' category. However, recent 'blowouts' in rabbit populations in Marlborough, Canterbury and Otago, from what may have appeared to be 'stable' low levels, illustrate the danger of making predictions on where the threshold now lies. The complexity and dynamic nature of the emerging post-RHD environment means that this is something that will only become apparent over time. It is therefore not a priority for research.

10.4. *Predictions on epidemiology*

The web of interrelated factors determining the behaviour of rabbit populations in New Zealand is unlikely to be unravelled in the foreseeable future. Henning (2003) observed that attempts to model the behaviour of RHD have failed. This is not surprising given the host of variables, many of which are unknowns:

- Viral attenuation (unknown) but likely to be at work because of the blood-group receptor susceptibility (Guillon et al 2009)
- The identity of the putative benign strain or strains in NZ and whether they influence immunity to virulent strains of RHD (unknown)
- Interactions between viral strains (unknown)
- Population immunity (unknown) – lack of an assay specific to the neutralising antibody.
- Serological profile in individuals over time
- Ingestion of degraded virus from fly spots and rabbit faeces (unknown)
- The period of natural resistance to RHD in young NZ rabbits and the change, if any, in this period in response to selection pressure from RHD (unknown). Recent literature also shows the reason for young rabbits lack of susceptibility: they do not express the blood group virus binding ligands (receptors) until they are older.
- Predation potential (dynamic)
- Breeding potential (dynamic)
- Field transmission and the role of vectors (unknown)
- Re-infestation potential (dynamic)
- Age and time of first exposure (unknown)
- Breeding profile over the year
- The persistence of the RHDV in the field (unknown) - is the virus ubiquitous in some habitats? Virus injected into bovine liver was still viable after 91 days in the field (Henning, 2003). There is no certainty that viral challenge of wild rabbits is not occurring before and after apparent epizootics; other triggers may be involved.

The lack of knowledge of these many factors influencing the behaviour of RHD in New Zealand enables one conclusion to be drawn with certainty:

… epidemiological predictions for RHD cannot be reliable.

This fact, together with the potential for population 'blowouts', viral attenuation, genetic resistance and the natural resistance/maternal immunity of young rabbits, leads to another conclusion.

… a conservative approach is advisable to managing risk in the more rabbit prone regions - survivors in an area known to have experienced an epizootic should be eliminated.

It will take many years to build a better understanding of the factors above and, even then, it may still not be possible to make reliable epidemiological predictions. In the meantime, the inadequate use of secondary control measures has led to an increasing number of properties in parts of Otago, Canterbury and Marlborough facing major primary control programmes. This is despite repeated advice, since before RHDV arrived in New Zealand, that ongoing secondary control should be undertaken to kill survivors of RHD (RCD Applicant Group, 1996). There are farmers who have clearly demonstrated that long-term suppression of rabbit populations on high and extreme rabbit prone land is achievable and affordable in the post-RHD environment with the current range of control tools. This was not the case before RHDV arrived in New Zealand (RCD Applicant Group, 1996). There is no guarantee that future blowouts will not occur, despite best efforts. If this happens though, the interval between primary controls will still have been much longer than historically in the decades prior to 1997.

In summary, research into the epidemiology of RHD in New Zealand is not an immediate priority for rabbit management at this time because, with the many unknowns, there is no obvious practical application to rabbit management, with one exception. There could be a case for an investigation into genetic resistance as discussed, making use of data from the 1997 pre-RHD serology and looking particularly at differences between isolated (fenced) and general populations, and between those subject to high selection pressure for genetic resistance (i.e. no rabbit control after epizootics) and those in which survivors of epizootics were removed. A populations geneticist could analyse the data and assess the implications. AgResearch at Invermay has expertise in this field and could be approached to comment on the scope of such an investigation. Any resulting research would likely require the assistance of skilled council staff with the field expertise to ensure appropriate site selection and sampling.

Recommendation

An investigation initiated by MAF and led by a populations geneticist to determine the presence of genetic resistance in feral rabbits and to consider the implications for management.

10.5. *Human behaviour*

The most pressing research questions relate, not to improving our understanding of RHD epidemiology, but to how to ensure that managers of rabbit prone land understand that control measures are necessary and, more importantly, act on this knowledge. Such action would reduce the risk to their businesses of periodic primary control programmes and help to limit factors that could lessen the effectiveness of RHD in the future.

Some farmers successfully suppressing post-RHD rabbit populations cite the fear of another population explosion as a major driver in their business planning; before RHD they experienced the pain and stress that resulted from losing control of the rabbit pest. So there may be some truth to the adage that each new generation of farmers has to re-discover the realities of rabbit management (Aspinall, pers. comm.). If so, the challenge is to help them to avoid learning the hard way before their businesses are put at risk.

Providing public funding to landholders to deal with rabbit population blowouts resulting from inadequate secondary control could very well maintain the problem, rather than encouraging a change in rabbit management practices.

A combination of technology transfer and targeted research would help to ensure the adoption of effective management tools and strategies on these rabbit prone lands. Full use should be made of the existing knowledge in related fields acquired by the Ministry of Agriculture, its predecessors, farm management academics and professionals, and institutions such as the NZ Landcare Trust.

Recommendation

A review, initiated by the Rabbit Coordination Group into how to ensure the adoption of successful approaches to rabbit management in the rabbit prone semi-arid lands.

10.6. *Serological monitoring*

Rabbit population monitoring (night-counts) by councils from the mid-1990s has built a very good picture of population trends within districts and on individual night-count routes; it should continue. Valuable datasets have been generated which provide well-supported evidence for decision-making in rabbit management. The cELISA does leave some uncertainty about the relationship between seropositivity and immunity and it would be in the interests of rabbit management to try to improve it. However, serological monitoring should continue while research into a more reliable assay is undertaken, especially if the relationship between cELISA reacting serum antibody and the protective neutralising antibody can be better established.

10.7. *Toxins*

The heavy reliance on the toxin 1080 and, to an increasing extent, pindone as the primary tools for regaining control of rabbit populations remains a weakness in New Zealand's rabbit management. Social, technical and financial limitations may well restrict their use in the future. Ideally, they should seldom be required in the post-RHD environment, however secondary control tools such as shooting are ineffective at widespread high rabbit densities and for this reason a primary toxin is necessary when ongoing control has been inadequate. There will always be some instances of high rabbit numbers and, without a toxin for primary poisoning, ecological values certainly would be at risk – there is no other effective method available to regain control. Research into finding alternative, socially and environmentally acceptable toxins for rabbit management should therefore continue as a priority. At the same time, research into more cost-effective approaches to primary poisoning might help to reduce the financial impacts of their use.

Recommendation – to public good research funders

The search for acceptable alternative toxins and for more cost-effective approaches to their use in rabbit control should continue as a priority.

10.8. *Promoting more resilient ecosystems in problem areas*

On many farms in New Zealand there are areas that are a net drain on the farming business – e.g. gorse, broom and nasella tussock; some rabbit infested land is in this category. Through tenure review or on freehold titles, landholders have been able to quit land of no pastoral or strategic value (refer to section 11), which has then been put to some other use - productive, conservation, recreational or otherwise. If no alternative uses were to emerge for these difficult areas, the option of encouraging their transformation into new and more resilient ecosystems arises. If public funds were required, the land could be covenanted or transferred into some form of regional or national public tenure to help lock in the public benefits. Retiring areas from grazing, while still controlling the rabbits, will in some cases encourage improved cover and the development of habitats less favourable to rabbits (refer to section 11), although vegetation change can be very slow and a commitment to rabbit control would be necessary during any transitional phase. In Australia, from the 1980s and partly in response to the 'One billion trees programme', a number of inexpensive and simple technologies were developed for establishing native forest species as permanent ecosystems on former pastoral land, using species endemic to the area (Potter project). Direct seeding was used with particular success.

It may be appropriate to review current knowledge in New Zealand on the potential establishment of endemic species on the most unproductive rabbit prone lands to create natural ecosystems less prone to damage by rabbits. Other functional benefits could also be considered such as habitats for native fauna, seed sources for natural spread of underrepresented species, wildlife corridors and carbon sequestration. Any such review could highlight aspects requiring further research, such as seed ecology of woody species.

Recommendation – to funders of public good research

A review of current knowledge on the potential establishment of endemic species on the most unproductive rabbit prone lands to create sustainable natural ecosystems less prone to damage by rabbits.

There are several Government initiatives that could financially assist this change in land use. The Afforestation Grant Scheme (AGS) is open to applicants seeking to establish native species (on what was bare land), as is the Permanent Forest Sink Initiative (PFSI) and the Emissions Trading Scheme (ETS).

10.9. *Asking the right questions, finding the answers*

Whichever aspects of rabbit management are prioritised for research, the usefulness of the potential outcomes, their relevance and their validity should always be carefully considered before committing public funds to such work (it appears that this has not always been the case). The scientific rigour applied to these questions must always be of the highest standard. If not, poorly informed decisions by landholders or others involved in rabbit management may result.

Independent scientific review of current and new research proposals and methodologies relating to rabbit management would help to ensure value for the public investment, especially as RHD now demands specialist knowledge well beyond the disciplines of those formerly involved in rabbit related research.

The Working Party on Sustainable Land Management made a very clear statement on what is required:

'For best effect high country research should be:

- *collaborative and coordinated;*
- *relevant to sustainability;*
- *hypothesis driven and quantified;*
- *verified and system interaction tested;*
- *interdisciplinary;*
- *have a planned technology transfer.'*

(Working Party for Sustainable Land Management, 1994)

11. Reform of land tenure, new land uses, new approaches

11.1. *Property rationalisation*

In 1992, the South Island High Country Committee of Federated Farmers highlighted the need to reform land tenure in order to achieve more sustainable management of the land, citing reduced farmer ownership of problems over the previous 20 years. Private ownership of 'commercial' land would bring '*a planned approach to the integration of production and conservation values* and a *' revived sense of ownership and responsibility*'.

'*Worldwide, the effects of land tenure in its various forms has led to either degradation or sustainability depending on the security of that tenure … Ownership of land will encourage wise land use … High Country people believe that land tenure reform is necessary to herald a new era. These reforms need to blend individual responsibility for land management decisions, with the needs and aspirations of a public concerned about the future of our mountain lands '*

(Federated Farmers High Country Committee, 1992).

The process of reforming pastoral lease tenure began under the Land Act 1948, mainly on leases in Otago, and has gradually continued over the last 11 years under the Crown Pastoral Land Act 1998. Many leases reviewed have been on rabbit prone land and some farmers have used the opportunity to rationalise their landholdings and strengthen their businesses (Murray, pers. comm.). A change in land use and/or the balance of land types within a property enables a re-evaluation of how to manage the threats posed by rabbits.

Table 5 gives some examples of the transformation (some through tenure review) of land of extreme rabbit proneness (formerly carrying less than half of one stock unit per hectare) into land with value providing a good return (financially or ecologically). These examples on rabbit prone land support the view of Federated Farmers and many others (Working Party for Sustainable Land Management, 1994) that security of tenure can encourage wise and more sustainable land use. The process is market-driven and there is still scope for further rationalisation of boundaries and enterprises to better manage the rabbit pest.

Table 5: Rationalisation of land

Event	Examples
Conversion into grapes	Bendigo Stn, Gibbston Area
Sheep grazing land into dairy	Lower Mackenzie Basin
Non irrigated to irrigated	Irrigation has transformed depleted rabbit prone land into high producing pasture that is most unfavourable to rabbits. Many examples in Central Otago.
Farms into lifestyle blocks	Changes to district plans have allowed more intensive habitation. While this has sometimes provided problems with co-ordinating pest control on small blocks, in general it has reduced rabbit populations, especially when lifestyle horticulture ventures are developed. It has allowed properties to sell off 'non-productive' rabbit prone land, giving a major cash injection to the remaining property to allow habitat changes, rabbit fencing, land development etc. to make it financially and physically easier to manage rabbits.
Conversion to orchards	In Central Otago, cherry orchards in particular, but also other fruits have been recently established on what was rabbit prone grazing land (e.g. Pisa Flats).
Conversion to conservation reserves	To protect examples of semi-arid land with rare flora or fauna present, large reserves have been established on formerly depleted farmland. The Department of Conservation has had the finance to control the rabbits. e.g. Flat Top Hill Reserve, Chaffer Beetle Reserve, Mahaka Katia Reserve, Tekapo Scientific Reserve.

There are sufficient examples of land that was seemingly worthless being turned into an important asset to make most landholders reluctant to '*give away currently worthless rabbit prone land*' (Robson, pers. comm.).

Tenure review, a voluntary process, has often resulted in the removal of higher land, formerly summer-grazed but with no inputs, from farming enterprises. There are conflicting opinions on whether this has resulted in increased pressure on lower country - making it more favourable to rabbits.

Land with the most obvious potential for rationalisation may already have been through tenure review and it may be a challenge to find sustainable solutions on some remaining leases. For some properties (e.g. in Central Otago), the worst rabbit land lies in a band that runs along the foothills between the most productive land, usually flat and irrigated, and the hill run country. There is not always an obvious solution to rationalising the tenure

of such ‘landlocked’ areas (refer also to section 10.8). In the case of Bendigo Station, this rabbit prone band contained stands of native Kanuka which, through tenure review, is now within a long thin reserve administered by the Department of Conservation. Together with the land converted to viticulture, this has effectively removed highly rabbit prone land from the station.

12. Other concerns for rabbit management

12.1. *Tb Vector control*

There has been a marked decrease in the number of rabbit predators in areas where Tb vector control programmes are targeting ferrets; these also remove cats as by-catch.

Ferrets and cats can play a very important role in the predation of young rabbits. They are only significant natural mortality agents when rabbit populations are of low to moderate density. At these levels, the ratio of predators to rabbits is sometimes sufficient for a ‘predator pit’ to exist so that rabbit numbers are less likely get to a level beyond the suppressing effect of the predators. Ferrets are most effective in destroying rabbits prior to their emergence from the stop. Cats play an important role as predators during the period when young rabbits have emerged from the breeding stop, but are still using it for cover.

Research during the early years of the RLMP, when rabbit numbers were high, showed that predator numbers in the SAL were insufficient to play a significant role in reducing overall rabbit numbers. The ‘predator pit’ situation did not exist. The large fluctuations in rabbit numbers that were occurring from the 1970’s to early 1990’s, due to continuous poisoning of rabbit populations, meant that ferret numbers could never be maintained at levels were they could play a major role. They were always in catch-up mode because of their inability to match the breeding potential of the rabbit.

However after the large-scale reduction in rabbit numbers under the RLMP, followed by a regime of continuing secondary control work, rabbit numbers remained low and steady. This allowed ferret populations to be maintained and they once again were able to play a part in helping to maintain rabbits at low levels. The dramatic increases in vegetation seen as a result of these continuing low rabbit levels (such as seen on Earnscleugh Station) also improved the hunting success of predators, especially for cats hunting rabbits above ground. Secondary control methods (fumigation, shooting and small pindone operations) are usually beneficial to predator survival because the carcasses provide food, particularly during winter and outside the rabbit breeding season.

In the Awatere Valley of Marlborough, landholders believe that Tb vector control of ferrets has been a very significant factor in some rapid increases in rabbit populations (refer to Figure 17) (Satterthwaite, pers. comm.).

Field recordings and observations round Omihi in North Canterbury during the 1990’s showed how the removal of ferrets (and cats) for Tb control could upset the predator/prey balance with the result that rabbits increased markedly in numbers. Similar results occurred in Central Otago including at one of the Otago Regional Council’s RHD monitor sites. This meant that the landholder had to increase the level of secondary control to the extent that a rabbit controller is now employed in conjunction with two other properties that were faced with the same situation.

12.2. *Technical standards and best practice*

A change under the Hazardous Substances and New Organisms Act 1996 has enabled individuals and contractors to obtain licences to use 1080, even with no knowledge of its optimum use in rabbit control (Sullivan, pers. comm.). The use of private/independent pest operators to carry out poison operations has in some instances resulted in very poor kills due to the poor technical standards. Reports have been received of poison programmes involving inadequate pre-feeding, excessive time periods between pre-feeds, lower than recommended bait application rates, rotten carrot bait and excessive or inadequate time periods between pre-feed and toxic applications.

Of greatest concern is the risk of re-creating the major bait and poison shyness problems of the past. Under the current user-pays regime, poison contractors are under pressure to cut costs to gain the work. Unforeseen problems, such as flying delays due to poor weather, can mean that extra costs are incurred that were not budgeted for. Landholders can stipulate poison programmes that are not regarded as best practice ('the piper calls the tune') even when contractors may be aware of the longer-term risks of this approach. As a result, there are properties in Canterbury and Marlborough still with high rabbit numbers because poor planning and incorrect decisions compromised the kill, despite the very significant expenditure incurred by the landholders. This short-term cost cutting approach can result in much higher long-term costs and, as the frequency of primary poisoning increases (with poor kills or inadequate secondary control between poisonings), the risk of bait and/or poison shyness also increases.

In Marlborough, pindone pellets are used exclusively, it has been many years since 1080 carrot was used there, although 1080 pellets were used about 3 years ago with very poor results - again attributed to poor technical standards (insufficient interval between pre-feeds and toxic application). Carrots have to be sourced from South Canterbury and the freight involved makes them very expensive. The use of pindone pellets also allows land to be grazed much sooner than after 1080 operations.

In Otago, a resource consent is not required to use 1080 but consents are required in Canterbury. ECan has applied for a regional resource consent in the hope that contractors will operate under its consent and meet the council's operating standards (Sullivan, pers. comm.).

The externalities arising from developing bait and/or poison shy rabbit populations are very significant and could very quickly seriously compromise rabbit management in some areas. For this reason it is essential that councils act collectively to seek appropriate changes to regulations and/or standards to prevent the problem from escalating (refer to recommendation in section 9.4).

12.3. *Seasonal changes shorten the operational window for primary control*

There has been a marked decline in the operational window for winter poisoning over the last decade or so. Poisoning in Otago used to start in late May, with works always well underway by Queens Birthday weekend. Carrot takes by rabbits would begin to decline by late September so aerial poisoning would finish then, but small pindone applications (e.g. lifestyle blocks) were continued until rabbits stopped eating carrot in early October. So the winter poisoning period there usually lasted for four months.

For the last three years at least, the climate has reduced the operational window for 1080 programmes to less than two months. The winters have been generally warmer and the grass still palatable well into winter. Warmer late winter temperatures have allowed grass

growth to get underway sooner; when there is sufficient fresh grass, the rabbits no longer take the carrot baits. It has typically been well into July before the proportion of rabbits eating carrot bait is sufficient for poisoning to start. By mid to late August, the rabbits no longer eat the carrot. Further north, in Canterbury, the operational window was already shorter than in Otago and weather conditions in recent years have shortened it further.

This has put tremendous pressure on rabbit control staff in these regions with the result that often the poisoning scheduled is not completed. The late start also affects farm management because poisoned areas cannot be grazed at the crucial feed shortage time in spring. The pressure to get the work done means toxic applications have been flown when there is a risk of rain, because to wait for a safe weather forecast would result in even less aerial poisoning being completed. There is pressure to allow only minimum times between pre-feeding and toxic application - to the extent of that feed carrot has still been present at the time of the toxic application.

If recent weather patterns continue, primary poisoning, particularly by aerial application, may no longer be a reliable fall-back.

12.4. *Lack of experienced and skilled rabbit controllers (rabbiters)*

After the integration of pest destruction boards into the regional councils (1989), the Government grants administered to boards through the APDC ceased. All the boards with significant areas of high and extreme rabbit prone land had received these grants.

The RLMP provided work and monies to retain enough former Pest Destruction Board (PDB) staff to service the properties within the programme and many people new to the industry took up the opportunity to start as private contractors. Council staff still carried out poison operations (1080 and pindone carrot) for a time but, once the full cost was being met by landholders through rates, many areas opted to move to a user-pays system. The former pest board staff in councils were no longer required and this resulted in large numbers of experienced pest controllers leaving the industry. Some areas opted to pay pest control rates to the councils to deliver secondary control work - principally in the form of night-shooting but, over time, these rate-paying areas reverted to a user-pays system (Robson, pers. comm.).

With the advent of RHD, nearly all landholders stopped using independent pest workers. However some landholders saw that a loss of experienced staff would pose a problem in later years and, to safeguard the future, retained them for other work such as pest plant control. At present, only the Otago Regional Council has retained enough experienced rabbit controllers to carry out major poisoning operations. Private contractors and landholders carry out this work in the Marlborough and Canterbury regions. The very short operational window available for primary poisoning means that other income sources are required to provide year-round employment for trained staff.

There is now a looming shortage of capable, experienced and trained pest workers for landholders to employ to carry out rabbit control work. Training is essential to ensure the effectiveness and safety of staff (e.g. night-shooting from motorcycles on rugged terrain and the handling of toxins).

Recommendation

Regional or central government initiatives to address the looming skills shortage for rabbit management.

12.5. *RLMP property plans*

An investigation may be warranted into whether the Rabbit and Land Management Programme Property Plans were effective mechanisms for 'locking in' the benefits derived from public funds; these will be expiring over the next few years. The plans placed conditions on recipients of Government funding through the RLMP such as requirements to maintain rabbit populations at certain levels and maintain rabbit proof fencing.

The goal of such a study should not be negative or backward looking; its purpose would be to gauge the value of such instruments for securing the benefits of public investment on private land - for example, the funding sought by Federated Farmers. The lessons learned from such an investigation may have a wider relevance than their application to Government intervention into pest management alone.

Recommendation – to MAF and the councils

Subject to any decision on public funding for rabbit control, an investigation may be warranted into whether the Rabbit and Land Management Programme Property Plans were effective mechanisms for 'locking in' the benefits derived from public funds.

12.6. *Land condition monitoring*

There may be a case for reviewing or undertaking case studies of the land condition monitoring initiated by the RLMP and taken over by landholders. How many have continued with monitoring? Has it been useful to them? Has it assisted with management decisions? What interpretation does it allow? Are there lessons for future monitoring? Can it be adapted to better meet landholders' needs?

Recommendation – to MAF

There may also be a case for reviewing the effectiveness of the land condition monitoring initiated by the Rabbit and Land Management Programme.

12.7. *Rabbit management on Crown Pastoral Land*

Another issue relates to the requirement for holders of pastoral leases under the Land Act 1948 to control or even 'eradicate' rabbits. In practice, the more recent Biosecurity Act 1993 has been given precedence for pest control on leases. Land Information New Zealand (LINZ) could consider investigating the benefits of taking a more engaged and active approach to rabbit management on pastoral and other Crown land, particularly if public funds were to be directed to rabbit control on leasehold land. Five-yearly inspections, for example, are inadequate for rabbit population monitoring and the current inspections are not undertaken by people trained in rabbit density assessment; these skills are held within regional councils.

- Could LINZ provide a conduit for allocating any public funds to rabbit control on leasehold land and play an active role in helping to ensure a lasting benefit from the investment?
- When rabbit populations exceed the limits imposed by Regional Pest Management Strategies, should the Commissioner of Crown Lands take a greater interest?
- Is there sufficient interaction between the Commissioner and regional councils in such cases?

- Would direct public funding for rabbit control, after deduction of rent, result in a net annual payment from taxpayers to lessees to occupy a pastoral lease in a 'caretaker' role?
- To what extent might any public funding for rabbit control be capitalized into the market value of leasehold (and freehold) properties, increase debt servicing after purchase and thereby reduce the effectiveness of the funding?

Reviewing these questions could be in the interests of current and future lessees as well as the Crown.

Recommendation

The Commissioner of Crown Lands should consider the need to take a more engaged and active approach to rabbit management on pastoral leases and confirm his position to lessees and councils.

13. Current management and funding arrangements

13.1. *Council funding related to rabbits*

The Regional Pest Management Strategies for the Southland, Otago, Canterbury and Marlborough regions require landholders to meet the full cost of rabbit control. Initially, the councils in Otago, Canterbury and Marlborough all had service delivery units able to undertake rabbit control. However, at the request of landholders, the Canterbury and Marlborough councils no longer offer rabbit control services; landholders or private contractors undertake this work.

The Otago Regional Council retained its pest control unit so that the option of having rabbit poison operations carried out would always be available to landholders. Landholders in Otago could employ private contractors but to date they have engaged the council to undertake all 1080 and all major pindone poisoning programmes. This unit can also provide secondary control but landholders or private contractors do most of this work. ECan employs a rabbit coordinator whose role is to assist properties with the planning and implementation of rabbit management.

The relationship between rabbit affected landholders and council staff appears to vary greatly between regions. In general, landholders get on well with field staff but many see councils as 'government departments' and expensive bureaucracy. Almost all the professional expertise and experience remaining in New Zealand, in respect to rabbits, lies within the councils. For this reason, and because of their established administrative structures, the councils' biosecurity/animal pest units may be appropriate for delivering any additional monetary or technical assistance to individuals or landholder groups.

Council expenditure and the relative contributions of occupiers and the wider regional community to rabbit-related activities are shown in the following tables.

Table 6: Funding formulae for rabbit management - Environment Southland

	Rural land occupiers (%)	The regional community (%)
Inspections/ compliance		100
Trend monitoring		100
Education and advice		100
Control	100	0
RHD		100

Table 7: Rabbit-related expenditure – Environment Southland

	$
Publicity pest animals and RHD serology	113,000
Compliance inspections (rabbits)	6,000
Monitoring rabbits	16,000
Total	$135,000

Table 8: Funding formulae for rabbit management – Otago Regional Council

	Rural land occupiers (%)	The regional community (%)
Inspections/ compliance		100
Trend monitoring		100
Education and advice		100
Control	100	0
RHD		100

Table 9: Rabbit-related expenditure – Otago Regional Council

	$
Implementation of RPMS including population trend monitoring	171,000
Education and publicity	20,000
RHD	44,000
Total	$235,000

Table 10: Funding formulae for rabbit management - ECan

	Rural land occupiers (%)	The regional community (%)
Inspections/ compliance		
High prone	33	67
Medium prone	50	50
Low prone	75	25
Monitoring	50	50
Education and advice	50	50
Control	100	0
RHD		100

Table 11: Rabbit-related expenditure - ECan

	$
Publicity pest animals	26,600
Pest management liaison committee	94,600
Compliance inspections (rabbits)	367,000
Monitoring rabbits	94,000
Pest control rating districts (e.g. Banks Peninsula)	80,000
RHD serology and monitoring	50,000
Total	$701,200

Table 12: Funding formulae for rabbit management – Marlborough District Council

	(%)	The regional community (%)
Control	100% rural occupiers	0
All other rabbit related work	75% general rate from all rural ratepayers	25 % general rate from all urban ratepayers

Table 13: Rabbit-related expenditure – Marlborough District Council

	$
Education, advice, inspections, compliance, population monitoring, RHD serology	$300,000

14. The case for further public funding

'In general, efficiency is best achieved by targeting the costs to those closest to a particular set of works where those paying have the power to act in respect of those works. If a decision-maker has to pay for the results of their action (or inaction), it may alter their behaviour to minimise any such resulting costs. This will lead to the least-cost outcome for society as a whole. However, if the costs resulting from their actions are borne by another party, there is little incentive for any change in behaviour, and this may result in a higher cost for society as a whole. Efficiency includes close targeting of costs to benefits as well as to those contributing to the problem (exacerbators). Equity is difficult to establish, particularly where there is a 'public good' component. In general there are no universally applicable guidelines.'

(Regional Pest Management Strategy, Canterbury)

14.1. *Criteria for public funding of resource management on private land*

There is often discussion over who 'owns' the environmental values on private lands, who benefits from their 'use' and who should pay for their protection. The Working Party on Sustainable Land Management looked carefully at this issue and concluded that public funding of resource management on 'private lands' could only be justified when all three of the following conditions prevailed:

1. *'There are public benefits, associated with the land, which are not captured (or able to be captured) by the private land owner (a situation of public goods and externalities and hence market failure).*
2. *The market process is prevented from finding the best land-uses, or supplying the sizes of enterprises best able, to maintain the condition of land resources in the long-term (a situation of market imperfection caused by the pastoral leasehold tenure and the Land Act 1948).*
3. *The current land-use is unable to meet the full requirements of land conservation and is therefore putting the public interest at risk.* '

(Working Party on Sustainable Land Management, 1994)

14.2. *Federated farmers proposal*

Federated Farmers considers that there are many farms where it is now unaffordable to control rabbits and where environmental values are very much at risk. The rabbit problem may have been exacerbated in some areas where rabbit predators have been removed following bovine Tb vector control. Federated Farmers believes that the Crown has a responsibility to work in partnership with landholders to protect environmental values on private land, especially on land that has little or no productive value and where farmers are facing high control costs. It would like the taxpayer to pay for half the cost of bringing rabbit populations down to acceptable levels on all properties that are under Notice of Direction from regional councils (refer to Appendices Two and Three).

14.3. *Responsibility for rabbit control*

Taylor Baines and Associates (1990) described the 1960s institutional environment for managing rabbits:

'In the 1960s, rabbit control was carried out by single-purpose agencies operating at the locality level (Local Government level), acting with little cost restraint, amongst attitudes

which insisted that total responsibility for killing rabbits lay with the local pest destruction board.' (Taylor Baines and Associates, 1990).

Following the phasing out of public funding for rabbit control in the 1980s (which had contributed as much as 80% of the rabbit control costs on some properties), the onus fell on landholders to fund their own rabbit control. Rabbit populations began to increase during the transition period as pest destruction boards struggled to cope with the diminishing taxpayer input.

The debate over who should pay for rabbit control, and the Government refusal in 1987 to allow the import of the myxoma virus as a biocontrol for rabbits, culminated in another period of taxpayer input in 1989, to a small number of very rabbit prone properties in the 'intractable' areas, via the $28 million Rabbit and Land Management Programme. The Task Force proposed public funding 'primarily for resource conservation' but also as 'partial compensation' for the Government's denial of myxomatosis.

Some farming businesses would not have remained viable without this public funding (Working Party on Sustainable Land Management, 1994). However, the responsibility for rabbit control on these properties was handed firmly back to landholders at the end of the programme in 1995, many with a property plan/land improvement agreement registered against their lease or title in which they agreed to hold rabbits at post RLMP levels and to maintain publicly funded improvements such as rabbit fences (some of these agreements are due to expire in 2010). Those with pastoral leases under the Land Act 1948 already have a clear obligation to control rabbits. Finally, the Regional Pest Management Strategies of Southland, Otago, Canterbury and Marlborough reinforce the message that the responsibility for rabbit control lies with the landholder.

Although some farmers worked hard to maintain the benefits of the RLMP, the limited range of tools available constrained the efforts of those on highly rabbit prone land. Locally, rabbit populations began to increase immediately after the RLMP and it was very clear that a new tool was required for rabbit control (RCD Applicant Group, 1996) without which it would have been unreasonable to expect landholders to meet their responsibility to control rabbits on the most rabbit prone lands.

The Working Party on Sustainable Management (1994) took a stronger line. It acknowledged the need for new tools for rabbit control (this was 3 years before the introduction of RHDV) but still concluded that individual landholders should be expected to carry the full cost of rabbit management (with the possible exception of those in the process of pastoral lease tenure review):

'*Despite the risks of losing the benefits achieved through the RLMP the Working Party considers that it is appropriate to end the subsidy cycle for rabbit control and related works on individual properties' ...* '*the positioning of the problem within the management of individual businesses has enabled landholders to see more clearly the ongoing costs to their operations and to make appropriate decisions'* … '*The future cost of rabbit control and management must then be borne by the landholder … All landholders with rabbit prone land must be encouraged to maintain the vigilance and effort required to keep rabbit numbers down. Legislative backing must be used to enforce rabbit control where necessary. Government support for the research effort to find effective and publicly acceptable new rabbit control tools must continue with high priority*
(Working Party on Sustainable Land Management, 1994).

Today, the unauthorised import of RHDV has introduced an addition to the existing suite of 'natural' control agents. Formal monitoring and observations by councils over the twelve years since RHD arrived shows that it has devastated rabbit populations. These observations, together with the example set by many farmers on land of high or extreme rabbit proneness, suggests that it is no longer unreasonable to expect all landholders to meet their responsibility to control rabbits. The councils report that many landholders who have brought high rabbit populations back under the MAL have since been maintaining them at low levels.

It could be said that the illegal introduction of RHD has negated the 'compensation for myxomatosis' argument used by the Task Force (not all farmers agree with this view) and that the subsequent effectiveness of RHD in enabling landholders to better control the impacts of rabbits on the environment has weakened the Task Force's 'resource conservation' justification for taxpayer assistance for rabbit control on private land.

A simplistic apportionment of production and environmental benefits between the landholder and the public is not appropriate. Landholders make active and passive use of environmental values and can derive social and economic benefits from their protection. Most would reject the suggestion that their only interest is in the productive benefits such values can offer them; many have a deep concern for the environment and it can be a major factor in their decision to live and work on the land. Their personal interest and satisfaction in safeguarding intergenerational benefits is often expressed in terms of 'leaving the land in better condition than it was found'.

14.4. *The market process*

This report has given examples of how the market process has been working to achieve more sustainable land use on rabbit prone lands. Some regional councils have voiced concern that intervention in the form of funding for rabbit control would hinder the necessary rationalisation by market forces of land use, property boundaries and land values.

14.5. *Equity issues*

During the preparation of this report, there has been considerable reaction to the potential inequity of providing public funds to a group of landholders whose rabbit populations are at unacceptable levels. Farmers and others have pointed out that many landholders have incurred considerable ongoing annual expenditure to successfully avoid such a situation. Should they be rewarded for their efforts? Furthermore, some see funding for primary poisoning as a disincentive to undertake adequate secondary control; as discussed elsewhere in this report, this would threaten the ongoing effectiveness of RHD.

14.6. *Is the environment sufficiently safeguarded?*

There is no question that many farmers have a deep respect for land they are responsible for and a concern about the threats posed by vertebrate pests such as the rabbit to New Zealand's natural values. Arguing for a biological control for rabbits in its well prepared 1992 publication 'Spirit of the High Country: The Search for Wise Land Use', the South Island High Country Committee of Federated Farmers graphically described the damage and cost attributed to rabbits. The committee summarised the risks to productive and environmental values with one sentence:

'*The best efforts of farm and conservation managers will come to nought without effective rabbit control.'*

The committee felt it was important to seek a balance between conservation and production but stressed that farmers wanted the responsibility for managing the land:

'*Conservation should be considered as a part of everyday management of our high country land. Too many people view conservation as an alternative to production. What we are striving to achieve is a balance where the land can be used to generate income but in manner which respects natural values. High country people do have a deep regard for the land and nature. It is important that they be allowed to take responsibility to determine how best to manage and protect the natural features of the high country.*'

These are important points and illustrate the naivety of the presumption that landholders only derive 'productive' benefits from their land.

Federated Farmers has raised the possibility that land abandonment could lead to the degradation of environmental values if public funding for rabbit control were not provided and has suggested that the full cost of rabbit control would then have to be met by the taxpayer (see Appendix Three). Unlike the situation of the late 1800's and early 1900's when land was abandoned because of insurmountable rabbit populations, there are now technologies available to control them. The presence of RHD has enhanced the effectiveness of these controls. The risk of land being abandoned and left to degrade is therefore unlikely in the foreseeable future.

Rabbit prone high country properties continue to change ownership, and there is no evidence to suggest a lack of willing buyers. Recent sales reveal little if any significant discount for rabbit prone Canterbury and Otago properties and they continue to sell at prices well above their productive value (Ward-Smith and Murray, pers. comm.). Market forces appear to have been working well – both in re-shaping land uses to those less favourable to rabbits and/or more capable of sustaining the costs of rabbit management (refer to section 9.6), and in rationalising property boundaries within or between land uses (Murray, pers. comm.).

Rabbit control costs for landholders within the semi-arid lands have always been a major item in farm expenditure. For some, the need to diversify (e.g. into grapes or tourism) or to seek off-farm income was clearly identified during the Rabbit and Land Management Programme. A number of owners of semi-arid rabbit prone properties have farms on the lowlands to complement their high country land. By such arrangements most properties with rabbits have been able to sustain the costs of rabbit control. Sometimes landholders' ability to carry out control operations of sufficient scale to get on top of the problem has been limited by the availability of seasonal finance, and there have been examples where landholders who were financially struggling to control rabbits have sold up; some were already marginal or uneconomic. While the rabbits may not have been the main factor, they have been the catalyst in the decision to sell (Robson, pers. comm.).

The new owners have often been from outside the semi-arid lands (such as former dairy or lowland farmers) with sufficient funds to regain control of the rabbit problem. Large-scale poison operations followed by effective ongoing secondary programs are the normal procedures to get rabbits under control, with subsequent 'rabbit maintenance' costs then more affordable. The reduction in rabbit densities then allows increased stocking, so rabbit control costs per stock unit decrease.

Quite often a neighbouring farmer will buy land with a 'rabbit problem'. These are often well-established properties with the finance and experience to 'solve the rabbit problem'. A recent example of this occurred in Canterbury when a landholder purchased a

neighbouring property with a higher proportion of rabbit prone land than his own. The purchase enabled him to eliminate a source of rabbit infestation, by introducing adequate rabbit management, and the resulting unit still had a better balance of 'good' versus rabbit prone land than the property sold (Ward-Smith, pers. comm.). Figure 10 illustrates the consequence of a change in rabbit management following the sale of a property in Central Otago. It should also be acknowledged that the standard of rabbit control could also fall when properties are sold or passed down to the next generation; the calibre of the operator is fundamental to all aspects of farm management.

There are concerns that direct taxpayer funding of rabbit control could interfere with market driven rationalisation, through tenure review or otherwise, of land into new property structures, new ownership or new land uses. Furthermore, in some cases, there could be conflicting goals between optimising public and private benefit – for example where sheep grazing following publicly funded rabbit control constrains the progression of vegetation towards a less favourable habitat for rabbits.

14.7. *Funding of research*

The market alone is unlikely to generate the necessary resources to fund ongoing research into rabbit management or to ensure that the results are fully disseminated to land owners in the affected areas. The rationale for public good funding for research into pest management is well established, either through the Foundation for Research Science and Technology or through operational research funding by central and local government agencies.

14.8. *Training*

There are emerging issues around the number of qualified staff available for rabbit control, with an aging workforce structure and limited numbers coming into the employment area (Trost, pers. comm.). Farmers and council staff have raised this matter as a significant concern. In many cases, landholders themselves will lack the skills to train such people and these employees frequently work alone (rather than in medium to large organisations that might otherwise have provided training). This fact, together with the wider public good benefits associated with employment and professional training, could justify funding through regional or central government initiatives. Furthermore, such training and employment should not be seen simply as an issue for rabbit management but at a wider level, because those involved in the industry will apply their skills to a range of pests (Trost, pers. comm.).

14.9. *Summary on funding*

If landholders did allow rabbit populations to increase without adequate control, then environmental values would be at risk. Effective rabbit control and prudent sheep grazing management is important to protect biodiversity and valued ecosystems; with increasing grazing pressure there is a corresponding increase in the risk to fragile soils. However, the effective management of rabbit populations on some of the most rabbit prone properties of the South Island has been demonstrated to be affordable and achievable in the post-RHD environment; council staff, their observations and their data support this conclusion.

Alongside the biocontrol RHD, the normal tools for rabbit control are allowing landholders to prevent ecological degradation on highly rabbit prone land. All councils have stressed that some landholders need to put more effort into secondary control to make best use of RHD and maintain rabbit populations at acceptable levels. The core arguments of

'compensation for no biocontrol' and 'resource conservation' put forward by the Rabbit and Land Management Task Force have been largely negated. Furthermore environmental values are safeguarded through the provisions of Regional Pest Management Strategies with a regulatory system that ensures that rabbit control will be implemented. The councils are confident in this system. Finally, farmers and others have indicated that it would be seen as inequitable to fund one group of landholders on whose land rabbit populations have not been suppressed; a user pays approach puts the responsibility where it belongs.

Farmers are able to share the 'public benefits' arising from the protection of the land resources of their properties from the threats posed by rabbits, including environmental values. Market forces have been working to rationalise land use, property size and land values to better enable the resulting enterprises to meet the requirements of rabbit management. Finally, current land uses have been able to meet the requirements of land conservation on those properties that have been maintaining effective control of rabbits since 1997. Clearly then, the three concurrent pre-conditions (section 14.1) put forward by the Working Party on Sustainable Land Management in justification for public funding of resource management on private land do not prevail.

Vexed questions

Many questions related to public funding of rabbit control have been raised by those consulted during the preparation of this report, including farmers of rabbit prone land - some appear biased; others are discomforting. Are they the right questions? Do they require answers?

- Who owns the environmental values on private land; who is responsible for them?
- If the public has a shared responsibility for pest control on private land, what criteria need to be applied to differentiate between pests?
- Would taxpayer funding of pest control prevent rationalisation of land use, property boundaries and land prices?
- Is there a way for the taxpayer to fund rabbit control that is equitable between farmers, including those faced with serious infestations of other pests?
- Is the crown responsible for managing pests on 'unproductive' land?
- What means are available to landholders to quit their unproductive land?
- Would taxpayer funding of pest control reduce landholder commitment to rabbit control?
- Would taxpayer funding for primary poisoning increase the reliance on toxins, encourage bait and/or poison shyness, and discourage secondary control and compromise RHD.
- Would taxpayer funding for rabbit control lead to rabbits being replaced by sheep?
- To what extent might any public funding for rabbit control be capitalized into the market value of leasehold (and freehold) properties, increase debt servicing after purchase and thereby reduce the effectiveness of the funding?

Some of these questions have been addressed in this report, others remain unanswered and there are many unknowns, but there is one statement that can be made with certainty - rabbits will remain a problem in the semi-arid lands of the South Island far into the foreseeable future.

15. Mechanisms to deliver effective rabbit management

The brief for this report asks for an examination of some possible models for delivering potential future funding to rabbit control; clearly this will be dependent on the purpose of funding. Public good funding for research, facilitation, coordination and information would be better targeted to institutions with existing responsibilities for these roles. Funding for on-ground rabbit control on particular properties, to organisations such as the former rabbit boards, is a different matter. It should not be automatically assumed that collective approaches to rabbit management are the most effective and most appropriate; with all 'rabbit board-like' structures there is a major issue in that landholders no longer 'own' their rabbit problem – it becomes the board's problem or the community's.

In general, as these organisations grow in size, and as they move further from targeted user-pays approaches to a flat per-hectare rate, the responsibility for rabbit control moves further from the landholder. The evidence presented earlier in this report suggests that this would not be in the best interests of rabbit management (refer to section 9). One of the important achievements of the RLMP was the change in attitude of many landholders to taking personal ownership of the rabbit problem on their land (Robson, pers. comm.).

15.1. *The Maniototo Model*

(Based on information supplied by MPM Ltd chairperson John Beattie)

With the integration of Pest Destruction Boards into the newly created regional councils in 1989, the Maniototo Pest Destruction Board ceased to exist. Local farmers then formed the Maniototo Pest Advisory Group to look after the interests of the area. When the option for user pays was offered to Otago landholders, the Maniototo farmers voted for continuation of a rating system. The advisory group had convinced them to vote for a continuation of the rating system to ensure cross-boundary control. Farms in the Maniototo were smaller and there was a lack of rabbit proof fencing between properties. This meant that they were more reliant on a community based system for successful rabbit control; in essence each landholder was reliant on their neighbours' performance.

However the group did not favour the rating system offered by the Otago Regional Council so, having seen the successful establishment of a company to run the Maniototo Irrigation Scheme (which took over the irrigation scheme from the Crown, reducing overheads and running costs and thus irrigation water charges), they proposed a similar corporate structure. They felt such a structure would work with pest control using a system where every property had its own account.

As a result, Maniototo Pest Management Limited (MPM Ltd) was established in 1997 and took responsibility for an area of approximately 250,000 hectares. Landholders within the Maniototo became shareholders. Each property's shareholding was initially based on local knowledge of the amount of work required to ensure the desired level of control; the shareholding can be adjusted. There are currently 85 shareholders with holdings ranging from 50 to 2500 shares. Each landholder pays a tax-deductible subscription based on their shareholding; in effect it is a de facto rating system. At present the annual subscription is $2.50 per share; of this, administration charges are 30 cents per share.

The subscriptions are put into property accounts from which administration and monitoring charges are deducted. The balance is held for work done on the property, be it night-shooting, helicopter-shooting or saved for a future poison operation. The company's property account is held in trust and currently totals $330,000.

The company has the legal right to enter shareholders' properties for the purpose of pest control and to charge that property for the work carried out. In return it undertakes to control the pests on the property in accordance with the Otago Regional Council's Regional Pest Management Strategy.

The successful operation of Maniototo Pest Management Limited provides some support to those who seek the re-establishment of rabbit boards as an answer to increasing rabbit numbers and the associated high costs of controlling them. This model works well for the Maniototo and the company operates successfully without public funding.

One reason for this success is that the Maniototo Basin is a distinct geophysical entity with its boundaries being mainly high altitude land of low rabbit proneness. Also the area is very community focused and the willingness to be included in such organisations is very high. Peer pressure from neighbours ensures that all landholders are involved - an essential criterion for successful cross-boundary rabbit control. The company has developed a protocol for procedure and consultation with its farmer clients and other landowners such as DOC, LINZ and forestry companies.

A very important factor in the success of such enterprises is the availability of skilled, dedicated and experienced staff. As noted elsewhere in this report, the shortage of such people is an increasing concern. The antisocial aspect of working at night, the distance from cities and the desire of young families to be closer to urban facilities means that young staff often leave the industry after training. Experience plays a big role in rabbit control because of the need to understand rabbit dynamics and seasonal influences, to be able to read rabbit sign, to know which techniques are appropriate for a particular situation and how and when to apply them. This knowledge and experience takes time to acquire.

Maniototo Pest Management Limited benefited from the strong farmer leadership in the Maniototo Pest Advisory Group that promoted its inception. They had gained the confidence of most landholders that the group would implement a scheme that would best suit the district. The company was also lucky in that there were enough older farmers around at the time of its establishment who appreciated the value of cross-boundary pest control and who never wanted to see the rabbit plagues of the past.

This company appreciates the need to monitor rabbit populations. All properties are inspected every 2 years and infestation levels recorded. Areas of concern are monitored more frequently, especially if a poison is indicated. Properties are still subject to inspections by Otago Regional Council staff to ensure compliance with the RPMS.

In summary, this approach to the management and funding of rabbit control has been successful and is a good model for groups of landholders wishing to adopt a system reminiscent of rabbit boards. By avoiding a flat per-hectare rating regime, the model is likely to more equitably allocate the control costs to the land concerned. An established structure of this nature may provide a good model for distributing any future pubic funds (e.g. via regional councils), if granted, as long as suitable safeguards and external technical and financial audit procedures are in place. However, an organisation such as this requires a strong community belief, good leadership and skilled staff, especially if it is to operate successfully without the Government contributions that sustained the rabbit boards until shortly before their demise.

15.2. *Southland Pest Eradication Society (SPES)*

(Based on information supplied by Environment Southland)

The Southland Pest Eradication Society was established in 1996 to control or eradicate rabbits over an area of about 100,000 hectares in south-eastern Southland. It is an incorporated society with a management committee and compulsory membership for its roughly three hundred landholders.

The main aim of the society is to ensure that rabbit levels do not rise above MMS 2 (the RPMS maximum allowable limit is 3). The three staff or contractors employed use night-shooting as their main control method; other methods used are fumigation of burrows, gun and dog, and also ferrets.

The current $200,000 of annual funding is obtained through a flat rate of two dollars per hectare on participating landholders, regardless of property characteristics (unlike the property-specific shareholding approach of Maniototo Pest Management Ltd). Environment Southland collects this on behalf of the society as part of its annual rates demand.

The land under SPES management would be categorised as having low to very low rabbit proneness. During the late 1970's and the 1980's, research demonstrated that if rabbit control ceased in large areas of New Zealand rabbit populations would remain stable with only small annual fluctuations (Gibb and Williams). Trials around the country showed no difference between areas with or without human control in these less rabbit prone areas. The SPES locality is very likely to fall into this category - there is high natural mortality in such populations and these factors alone usually keep rabbits at very low numbers. Typical mortality agents are drowning of young in their stops (Southland's high rainfall and heavy soils make this a major natural control factor), predation by mustelids, and disease (e.g. coccidiosis and internal parasites) favoured by the lush grass sward - the dominant ground cover in Southland. There are many other areas in Southland of similar rabbit proneness to the SPES area that receive little or no control input and yet, while there are fluctuations, the rabbit populations in these areas remain at very low levels.

The society has a very high cost structure and uses methods with a high labour component; it may not be a good model for how landholders can successfully work together to control rabbits on more rabbit prone land. However it is an example of how a structure, similar to past rabbit boards, can be established. As in the Maniototo, a group of farmers convinced landholders in the district to pay rates and join a rabbit control organisation. In this case, collecting the rabbit rates via the Regional Council's rating system overcame a major administration cost.

An idea of the real cost of a 'rabbit board' structure is given by the two dollars per hectare cost of the SPES, and this is an area of low to very low rabbit proneness where little or no control is actually necessary. In high and extreme rabbit prone areas, rabbit rates would need to be very much higher.

When the former pest destruction boards were denied the dollar-for-dollar Government subsidies, they struggled as the true costs of rabbit control under such structures became apparent. Although the pest board regime continued for a time after the formation of regional councils, the high rabbit rates required to keep the system running were the principal reason for the widespread move to user-pays rabbit control. The user-pays system can also be much more equitable between landholders; it ensures that the real cost of rabbit management is met by the properties on which it is incurred.

15.3. *Animal Health Board*

The Animal Health Board (AHB) is the agency responsible for the eradication of bovine tuberculosis (TB) from New Zealand's cattle and deer herds. The programme operates under a National Pest Management Strategy developed in accordance with the Biosecurity Act 1993. The AHB is the Management Agency as defined by the Biosecurity Act; it is a non-profit making incorporated society. Prior to the formation of the AHB, pest destruction boards were responsible for bovine Tb control.

Spending on control of bovine Tb in 2007 was approximately $82 million - $45 million from the private sector and $37 million from local and central government. Private sector spending included $17 million from dairy farmer levies. The AHB engages contractors to reduce the principal vector of Tb, the brushtailed possum, over designated blocks of land. Ferrets are known carriers of the disease and are also targeted.

The density levels to which Tb vectors must be reduced are stipulated in the contracts and post control monitoring is carried out to ensure that levels have been reduced as specified before payment is made. The competition resulting from the tendering of these contracts greatly reduced Tb vector control programme costs (Robson, pers. comm.).

The requirement to reduce Tb vector densities to specified levels before payment is made to the contractor has been raised by landholders as a possible approach to rabbit control operations. This may appear attractive, but the cost of post-poison rabbit population assessments (e.g. to ensure densities are at or below MMS 2) would be high (Robson, pers. comm.) and there are limited control options available to rectify a 1080 poison failure in rabbit control because repeating the programme within the next 3 years would be in conflict with best practice. Poisoning costs would also need to increase to cover the risk of failure or to meet the cost of insurance for possible failures. For these reasons, it is essential that poisoning programmes are well planned and executed to minimise the risks of failure. Ideally, our reliance on toxins should be reduced or eliminated by the use of other existing or new control measures (ECan RPMS, 2005).

The bovine Tb programme is a national scheme and involves large sums of money. Local and central government play the major role in funding and without this input the scheme would not be viable. A national approach to managing a single pest where the problem is largely confined to semi-arid high country areas of Otago, Canterbury and Marlborough seems unwarranted; a local approach in which landholders (or small groups of landholders) have a clear responsibility for rabbit management will be more effective.

15.4. *Regional council pest liaison committees*

Environment Canterbury runs a number of Pest Liaison Committees whose purpose is to provide advice to ECan on implementing and funding the strategy (Canterbury RPMS. 2005 - 2015). These are forums for discussion on a wide range of pest management issues and processes, and they provide advice on the effectiveness and efficiency of pest management in their districts. The members of these committees act as an interface between landholders and the Biosecurity Unit of ECan which is, of course, reliant on effective and genuine liaison between committee members and the landholders in their communities. In practice they may acquire a general understanding of pests, both plant and animal, but not necessarily an in-depth knowledge of any one pest or its management. They may be able to function as one of several conduits for channelling information but seem an unsuitable vehicle for dispensing Government funding. After the

arrival of RHDV in 1997, the members of the Upper Waitaki pest liaison committee decided there was no further need for the committee to continue (Sullivan, pers. comm.).

15.5. *The Federated Farmers proposal*

15.5.1. Rationale

In March 2009, Federated Farmers of New Zealand proposed the formation of autonomous boards whose areas would be based on geographic boundaries (refer to Appendices Two and Three). Volunteers from within each area would run these and each board would be responsible for 'service delivery in managing the re-emergence of the rabbit problem'.

'The Board would oversee the infrastructure including:

- *Contract/bulk procurement of all on-ground and aerial resources*
- *Organising operational application*
- *Streamlining resource consents*
- *Establishing best practice methodology*
- *Pooling of knowledge and resources*
- *Assist with further R & D into biological control*
- *Liaison with regional authorities'*

(Refer to Appendix Three)

Federated Farmers proposed that central government provide public funds to meet half the cost of the rabbit control measures necessary for landholders to act on Notices of Direction from councils. Federated Farmers was concerned that if landholders' businesses became uneconomic they might abandon the land. Further rationale given for taxpayer contributions to rabbit control was that such funding:

- *'Is an acknowledgement by the Crown of its responsibilities to the environment detailed in its 'Objectives for the South Island High Country'* [this may be a reference to the non-statutory objectives of a former Labour government cabinet, rather than those of the 'Crown'].
- *Is a method of ensuring that the land rehabilitation gains post-RHD are not lost.*
- *Recognises that effective rabbit control is a benefit to the nation as a whole from environmental and economic perspectives.*
- *Protects the financial viability of rabbit prone properties.'*

Other points given in the proposal in support of public funding for rabbit control are:

- '*Rabbits are detrimental to the environment, our natural biodiversity and productivity.*
- *Rabbit control should not be the sole responsibility of the landholder. They were not introduced by landholders.*
- *Where costs become excessive, it is equitable for the public to pay a share of the control costs.*
- *The concentration on Tb vector control has led to a decrease in predator[s] which, in turn, is exacerbating the explosion in rabbit numbers'.*
- *Cost delays and resources of obtaining resource consents* [for primary poison operations].

- *Action is needed now to ensure the problem does not get out of control …*
- *Some expertise in rabbit control has been lost during the years RHD was universally effective.'*

Other points offered in support of the proposal (Ward & Satterthwaite, pers. comm.):

- The rabbit is the only pest that is a major threat to the soil (and water).
- The huge breeding capacity of rabbits is unique among vertebrate pests in NZ.
- Hieracium infestation has exacerbated the rabbit problem.
- The terrain of some properties makes secondary control measures harder to implement.
- It can be difficult to attract permanent staff for secondary control work, especially on isolated properties.
- Rabbit control is becoming unaffordable.
- The greatest expenditure is often on the most unproductive land, in some cases land that is never grazed.

The supporting argument in the proposal suggests that rabbits might have been 'overcome' were it not for past changes in the nation's approach to rabbit control and implies that, post-RHD, the rabbit problem can be 'overcome'. Few farmers would subscribe to this view - rabbits will remain a problem in the semi-arid lands of the South Island far into the foreseeable future. It should be remembered that the 'eradication' policy was abandoned thirty years ago in recognition that the 'taxpayer element of rabbit control funding could not be allowed to grow unconstrained in pursuit of impossible goals' (Taylor Baines and Associates, 1990). Any decision to allocate public funds directly to rabbit control in response to the request from Federated Farmers should be made in the expectation that it will be for the long haul. There would also need to be clarity as to whether such taxpayer funds were intended solely to protect environmental values or also to protect '*the financial viability of rabbit prone properties*' as put forward in the proposal.

15.5.2. A National Pest Management Strategy for rabbits

One component of the Federated Farmers proposal is the development of a National Pest Management Strategy (NPMS). This is expected to provide the 'framework' for a 'formal partnership' between the proposed boards, the councils and central government '*for a 50/50 split [central government and landholder] on costings on a property by property basis where notices of direction have been issued.*' However, the organisation is not explicit as to whether it is actually making a proposal per Section 58 of the Biosecurity Act 1993 and its amendments.

It is beyond the scope of this report to assess this proposal against the requirements of the Biosecurity Act 1993 and its amendments. It can be said though, that the statutory process for the development of a NPMS, its approval by Order in Council and the specifying (and possibly the establishment) of a Management Agency to implement it could take a very long time. Furthermore, the outcome, including any funding provisions, would be by no means certain. The time required to complete due process may not enable public funding to be delivered with the urgency sought by Federated Farmers.

It is also beyond the scope of this report to assess whether central government could lawfully fund rabbit control programmes on private land on an ongoing basis by any other means than under a National Pest Management Strategy. Nor has it

been determined whether central government funds could be directed to rabbit control through councils whose Regional Pest Management Strategies require occupiers to meet the full cost of control.

If serious consideration were to be given to providing the funding requested by Federated Farmers via a National Pest Management Strategy, as outlined in their proposal, it would be necessary to first investigate whether the proposal could meet the requirements the Biosecurity Act 1993 and its amendments.

15.5.3. Allocating funding to properties under notice of direction

The intent of the Federated Farmers proposal is that public funds would only be available to those occupiers who are under Notices of Direction – 50 percent of the cost of rabbit control. Federated Farmers may have overlooked the fact that some occupiers whose land exceeds the maximum allowable limits are not necessarily under a 'notice' of direction' but may still have committed to 'approved control programmes'. Large areas in the Otago and Marlborough regions are in this category. However, this minor point could easily be rectified by providing any public funds to occupiers whose land exceeds the council limits, rather than to those under Notice of Direction.

15.5.4. Proposed boards

Nearly 90 percent of the costs of some Pest Destruction Boards were met by public funding, with staffing levels in 1990 commonly at one staff member for every 20,000 to 50,000 hectares (Taylor Baines and Assoc, 1990). However, this is not what is envisaged by Federated Farmers. The proposed boards are expected to be voluntary, yet with the responsibility to be available for governance, service delivery and an ambitious range of tasks (refer to section 15.5.1). Such an arrangement could place a considerable burden on the few untrained volunteers prepared to take this work on and could constitute a risk to the proper use of public funds and the skilled implementation of well-planned control programmes. A board with formalised administrative and financial structures, trained staff and subject to audit would be more sustainable and would give better confidence that public funds were properly used to best effect (Federated Farmers has suggested that funding of for rabbit control be distributed to boards through the regional councils and that the councils also audit the work of the boards). Maniototo Pest Management Ltd and the Southland Pest Eradication Society appear to be safer models for distributing public funds.

The boards proposed by Federated Farmers could own the required equipment for rabbit control and employ staff to carry out the control work. Alternatively they could tender the work to contractors. However aerial poisoning equipment (cutters, screens etc.) are expensive items and can only be used during the operational window for primary poison programmes - a very short period in a year. So the number of contractors tendering for such work could be very small (in Otago the regional council has its own service delivery unit to ensure control programmes can be undertaken).

The Federated Farmers proposal does not mention the importance secondary control methods. It is to be hoped that the main role of such boards would be to encourage all landholders within the locality to implement effective secondary measures, follow up after poison programmes and extend the primary control interval, thereby limiting the development of bait and/or poison shyness and reducing the reliance on toxins.

There is no reason why the proposed boards could not offer such work on a scale that would give greater continuity of work to the contractor, and at a lower cost to the landholders concerned.

15.5.5. Equity

A significant difference between the operation of the model proposed by Federated Farmers and the other models considered here is the implication that there will be no funding for landholders on equally rabbit prone land who have managed to maintain rabbit populations at levels below the council limits. This point has been raised by a number of the landholders contacted during the preparation of this report and cannot be ignored.

Without doubt there will be landholders who have worked hard on rabbits but who, for a various reasons, have been unable to prevent the populations from increasing. Conversely, councils and farmers stress that there are others who have undertaken little or no rabbit control since RHD arrived in 1997. There is no obvious practical way to differentiate between landholders on the basis of the quantity and quality of the control effort because it would require subjective assessments of factors such as the level of expertise (e.g. recreational versus professional hunters) and the suitability of the techniques for the terrain, cover and population. Any decision to commit public funds to primary poisoning programmes, as proposed, will require an acceptance that the allocation cannot be equitable between landholders.

Equity was a major issue during the establishment of the Rabbit and Land Management Programme – those with low rabbit populations at the time, even on highly rabbit prone land, were generally excluded and this led to real resentment (Aspinall pers. comm.) (Taylor Baines, 1990). With targeted funding to a delineated group of landholders there will always be others left 'outside the line' and it may not be easy for Government to find an explanation they will accept.

There is also a concern that the proposed intervention for primary control may send the wrong signals and reduce the effort on secondary measures aimed at maintaining rabbit populations at low and stable levels. Perhaps a deferred payment system for financing high cost operations where normal banking finance was not available would be more equitable.

15.5.6. Ensuring public investment is protected

Farmers and others consulted agree that it is reasonable for the public to expect that any investment into rabbit control would be protected. Is there any way of securing this public benefit into the future?

Some of the suggestions put forward by farmers:

- Enforce secondary control to ensure rabbit populations stay low – how?
- Prescribe a minimum return interval for funded rabbit control – 5 years? 10 years?
- Require a lower MAL on funded properties and stipulate enforcement above it.
- Peer pressure from other farmers will ensure a responsible approach.

Another option would be to require recipients of taxpayer funds to enter into a legal agreement committing them to certain actions; the RLMP Property Plans are an example of this approach (refer to section 12.5). However, it is doubtful that compliance could be defensibly measured by the level and quality of input; outcome monitoring seems more

realistic but any disputes resolution would still need to address what had caused the outcome, and that would not be straightforward.

16. Promoting effective rabbit management

'Sometimes the best way to learn is to get the old guard to talk to the young ones' (Aspinall, pers. comm.)

This report shows that there is a wide spectrum of landholders – some successfully managing to control rabbits and others who are struggling. There is a common belief by landholders in difficulty that their property is the most rabbit prone and that their situation is unique. They sometimes feel that techniques that have been successful elsewhere would not work in their situation and often claim that those properties which have rabbits under control were 'never rabbitty anyway'. It is not that different methods are used by landholders; it is how they are implemented and at what intensity that makes the difference. While affordability can be a main limitation, it is more often to do with attitude, commitment and, most of all, priority (Robson, per comm.).

The rabbit management techniques that have proved to be successful need to be widely disseminated and the most effective way for this to happen is on the ground, often farmer-to-farmer. There have been plenty of studies over the years into where farmers obtain their information and into what factors lead them to adopt new approaches to managing land. Full use should be made of these. Written material will have limited impact because landholders like to see things firsthand. Recommendations from peers are often more readily accepted than verbal or written material from council staff.

16.1. *Supporting collective action*

Community approaches to pest management offer many real advantages but it would be folly to presume that collective action is therefore necessary or even desirable in every case. There is an inherent risk in any group approach to managing a pest such as the rabbit, which must sometimes must be countered with such single-minded determination that 'collective' could translate to a loss of responsibility, less ownership of the problem and inadequate action.

Central and local government agencies can often provide information, training, technical assistance and financial resources in a more efficient, effective and more integrated way to groups of landholders than to individuals. It may be harder to sustain voluntary groups though if the benefits were to be directed to only one or two individuals as in the model put forward by Federated Farmers.

Recommendation

Central and regional government agencies must be ready to respond with information, training and technical assistance where landholders initiate collective approaches to rabbit management.

A study of groups working together on resource-based problems in Australia listed the following as common characteristics of the most effective community groups (Lough, 1991):

1. They have clearly defined and understood problems.
2. They have good leaders who delegate, share responsibilities and workload and involve members.

3. They know where they are going and have a clear, achievable plan of how to get there.
4. They enjoy constructive partnerships with agencies.
5. They tap local resources first before seeking public funding.
6. They have interesting meetings with a clear purpose.
7. They do things on the ground.
8. They have credibility in their local community, reinforced by a group identity and recognition of members.
9. They have boundaries appropriate for the physical and social landscape.

Groups formed to work together on rabbit management are more likely to be successful when the motivation for their formation comes from within (Lough, 1991) (Aspinall, pers. comm.); the Maniototo and the Southland Pest Eradication Society landholders have demonstrated this. It is interesting that such collectives have not come together in highly rabbit prone lands elsewhere in Otago and Canterbury, or in Marlborough where the initiative for the Federated Farmers proposal was born (Ward, pers. comm.). When landholders come together to lobby on particular resource-based issues and/or to obtain access to funding, such groups are less likely to endure after the political issue has passed or when funding ceases (Lough, 1991).

16.2. *Benefits and risks of collective action on rabbit control*

The use of different control methods at different times enables rabbits to move from uncontrolled areas into recently controlled areas, sometimes despite rabbit proof fences or geographical features. For this reason there can be real benefit in coordinating rabbit control on a wider scale and community groups can help to facilitate this. By engaging in joint operations, the per-hectare costs diminish with economies of scale and rabbits across the whole area are destroyed at once. Groups may be able to jointly seek resource consents for poison operations where necessary. Although such coordination does not necessarily require collaboration on each other's properties, peer pressure can help to ensure that the required work is done. The collective peer pressure of a group can be much stronger than that of an individual.

Collectively, a group can often better access technical assistance and information from organisations such as government departments, councils, universities and research institutions; members can learn from each other through group discussion and support, on-ground field visits and liaison with other similar groups. As the Maniototo and Southland farmers have shown, if a group is large enough, it can plan operations, potentially own equipment for rabbit control and offer year round employment to staff or contractors. Even a group as small as two or three landholders could employ, and arrange training for, a person to undertake rabbit control on each property, supplemented as necessary with other farm work to create a fulltime position. There is of course no need to formalise a 'group' to take this course of action.

As discussed earlier though, the formation of community groups for rabbit management comes with the risk that landholders may lose the individual responsibility and vigilance required for effective rabbit control on lands of high and extreme rabbit proneness (Campbell, pers. comm.) This loss of responsibility could be exacerbated if such groups form for the purpose of obtaining Government funding rather than a genuine motivation to work together toward a common goal.

16.3. *Facilitation/coordination*

Successful community groups often rely on the motivation and leadership of one or two people prepared to commit their time to administer, facilitate and coordinate activities (Aspinall, pers. comm.). The individual burden this imposes can threaten the effectiveness and survival of a group; this is an area where councils can offer real support and for which they are already funded (Sullivan, pers. comm.)

'*Environment Canterbury supports and encourages locally initiated activities to improve land and water management … fostering a similar approach to pest control would bring similar benefits and would provide a link to integrate biodiversity management*' (Canterbury Regional Pest Management Strategy 2005 – 2015)

ECan has a 'Community Initiatives Programme' specifically to help local communities control pests to lower thresholds than required by its Regional Pest Management Strategy. The Banks Peninsula community initiated such a programme recently to control possums for gains in biodiversity and to help keep Banks Peninsula free of Tb; the programme is now in its third year.

Voluntary pest control community groups, with a particular focus on rabbits, may benefit from the assistance of trained facilitators from councils, well-informed on rabbit management. They could relieve community group leaders of some of the administrative and organisational workload, ensure groups had access to good information and aid in the flow of information and ideas between groups. However, the motivation to form such groups should really come from the landholders. Environment Canterbury has a full-time rabbit coordinator funded by the general rate. Additional field staff may be able to perform this function but any potential crossover between facilitation and enforcement roles may require consideration.

Recommendation

Council pest management staff at the interface with landholders should be given the support, technical information and professional development required to enable them to fulfil their roles.

16.4. *Providing information*

Over many years, the former Tussock Grassland and Mountain Lands Institute, the Rabbit and Land Management Programme and the associated Semi-arid Lands Research Group each provided a strong focus and exchange of information on the management of these lands. Their loss, and the subsequent loss of rabbit management expertise from within some councils, means that there has been less impetus, cohesion and continuity available to maintain this focus.

The recent formation of the Rabbit Coordination Group (RCG), comprising Federated Farmers and regional and central government pest management representatives may go some way to addressing this (a body of this structure was proposed in 1998 as a 'successor' to the RCD Applicant Group). Widening the membership of the group to include selected science providers could expose it to allegations of 'capture' by competing science institutions.

Perhaps there is scope for taking a step further and creating a very small group, operating from a broader land management perspective but knowledgeable on RHD and rabbit management, whose role was to promote best practice in all aspects of rabbit management, provide training and well-supported technical information and play a key

role in guiding research. Such a group could report to councils collectively, to MAF, the Biosecurity Managers Group or even to the High Country Commission proposed by the Parliamentary Commissioner for the Environment (Wright, 2009). This concept would require greater analysis than given here.

Recommendation – to MAF and the councils

Consideration should be given to the creation of a small specialist capability, operating from a broader land management perspective but knowledgeable on RHD and rabbit management, whose role is to promote best practice in all aspects of rabbit management, provide training and well-supported technical information and play a key role in guiding research.

Sources of information

An examination of where farmers obtain information on managing the rabbit pest took place within a survey of farmers associated with the Rabbit and Land Management Programme undertaken by Taylor Baines and Associates (1996). Key sources of information on rabbit control, in order of importance were:

1. Regional council staff ('*by far the most important source*')
2. 'Rabbit Fact Pack' and RLMP newsletter
3. Other farmers
4. Own experience (including experience on former pest boards)
5. Rabbiters
6. Reports and publications (very low percentage)

However, these rankings will have changed with the loss of service delivery and skilled staff from councils and the subsequent addition of a viral biocontrol into the mix of control factors.

There is something of a void in the availability of authoritative, practical and scientific advice on RHD. If the focus had been on the prevention of RHD in rabbits (as in Europe for example), this void would have been filled by practitioners and scientists in veterinary science, virology, immunology, genetics and so on. However in New Zealand, where the aim is to encourage the deaths of rabbits from RHD, veterinary practitioners in particular are faced with an ethical dilemma; the void in specialist information and science appears to have been filled to an extent by generalists such as ecologists, farmers, consultants, pest managers etc. Research budgets should be directed towards the correct scientific disciplines.

Farmers can consult a veterinarian about the best approaches for limiting the development of genetic resistance to anthelmintics in the internal parasites of their sheep for example, but whom can they turn to for authoritative, evidence-based, up-to-date advice on limiting the development of genetic resistance or immunity to RHD in their feral rabbits? Council staff at the interface with landholders should be given whatever support, technical information and professional development is required to enable them to better fulfil this role; consideration could be given to taking on additional staff within councils or to councils and MAF collectively employing or contracting a small specialist capability to work across the regions with regular liaison with the Rabbit Coordination Group and the Biosecurity Managers (per the recommendation earlier in this section).

The Rabbit Fact Pack is an excellent publication that was produced by MAF and the Otago, Canterbury and former Nelson-Marlborough Regional Councils. It was distributed widely to those involved in rabbit control, including landholders, and contains practical and technical information about rabbit control, rabbit biology, poisons and fumigants, shooting and other control methods. Its loose-leaved format enables it to be updated with new information but there have been no updates on rabbit management since 1992 (a Forestry Fact Pack update was issued in 1994).

The Rabbit Fact Pack should now be updated with current information on RHD reviewed by experts able to comment authoritatively on the disease (e.g. immunologists and veterinary scientists). The Rabbit Coordination Group could help to initiate this update. The Rabbit Fact Pack and ongoing updates could then be provided as a matter of course to all individuals and landholder groups involved in rabbit management, particularly those currently facing difficulties with rabbit control.

Recommendation - MAF and the councils

The 'Rabbit Fact Pack' information resource should now be updated with current information on RHD reviewed by experts able to comment authoritatively on the disease.

The Fact Pack mailing list could also be used for distributing an associated 'newsletter' or flyer to cover other aspects of managing rabbits in the post RHD environment, including updates on any new research findings, highlighting areas of uncertainty and their implications for management. Councils could prepare these collectively to ensure consistent messages across regions.

The Otago Regional Council has used its website, information sheets, field days and staff to provide information and advice on RHD (including the first few years after its arrival) always emphasising the importance of killing survivors. Other councils have indicated that they also provide information on successful rabbit control techniques to their region's landholders. Better use could be made of council websites in Canterbury and Marlborough (and Southland) to provide more information about RHD – details about the disease, reasons for targeting survivors, guidance on rabbit management techniques, the importance of best practice (especially with primary control) and regional trends in rabbit populations.

Recommendation

Better use could be made of some council websites to provide comprehensive information about RHD.

A series of field days held at sites in each of the three regions would allow a 'hands on' exchange between landholders. Such field days need to be held with sufficient frequency to enable landholders to share and refresh their knowledge and keep up with new developments.

Recommendation – to councils

Regular field days would allow a 'hands on' exchange between landholders and enable them to keep up to date with best practice in rabbit management in the post-RHD environment.

17. Conclusions

The rabbit problem is largely confined to the semi-arid lands of Otago, Canterbury and Marlborough. Elsewhere in New Zealand, rabbit populations have generally remained low, with only local minor control programmes required. Effective management of rabbits in the semi-arid lands of the South Island high country is of the utmost importance to counter the significant threat they pose to production and environmental values.

Epidemiological predictions for RHD cannot be reliable. Survivors of rabbit haemorrhagic disease should be targeted with conventional control methods to prevent the young immune rabbits from going on to breed. This will also limit the potential for viral attenuation and the development of genetic resistance in rabbits.

While ongoing success cannot be guaranteed, there are many examples of the successful use of secondary control techniques to maintain low rabbit numbers on semi-arid lands, including some of the most rabbit prone lands in New Zealand. Some common factors of success include landholders accepting responsibility for dealing with the problem, planning for an ongoing commitment to control and using techniques appropriate for the terrain and for the rabbit population density.

It must be stressed that there are many properties where rabbit populations have increased in recent years, sometime to levels requiring very costly control programmes for landholders. In cases, the level of ongoing control may have been inadequate or the measures applied miss-matched to the level of infestation.

The councils have confidence in the effectiveness of their regulatory measures in limiting the occurrence of unacceptably high rabbit populations. This will help to protect environmental values but, when landholders face difficulty with rabbit control, the goal should be to work positively with them in planning the best approaches and in determining roles, responsibilities and timeframes for action.

There will continue to be a reliance on toxins such as 1080 and pindone but poorly conducted poisoning programmes could compromise their effectiveness.

Before committing funds to research for rabbit management, there should be careful evaluation of the usefulness of the potential outcomes, their relevance and their validity. Independent scientific review of current and new research proposals and methodologies relating to rabbit management would help to ensure value for the public investment, especially as RHD now demands specialist knowledge well beyond the disciplines of those formerly involved in rabbit related research.

It may be possible to improve the reliability of tests for assessing the immunity of rabbit populations to RHD. Recent international research also suggests that there is a case for determining the presence of genetic resistance to RHD in rabbit populations and assessing the implications.

Market forces have been working to re-shape land uses and to rationalise property boundaries within or between land uses. These changes have resulted in some enterprises more capable of sustaining effective rabbit management.

There is a looming shortage of capable, experienced and qualified pest workers for the increased effort into rabbit control that will be necessary, there will also be a greater need for authoritative practical and scientific advice for landholders.

Community approaches offer better coordination across property boundaries, access to technical assistance and information, and economies of scale; they can also make it easier for agencies to provide information, training and technical assistance.

The combined evidence presented in this report does not provide strong support to a case for the taxpayer to fund rabbit control on private land, even though some farmers are faced with costly programmes to counter increasing rabbit numbers. If such funds were to be provided, there are many difficult questions to consider such as equity and how to ensure that effective rabbit management thereafter secures the public benefit into the future.

Several possible mechanisms for delivering public funding have been examined. Of these, Maniototo Pest Management Ltd could be a suitable model. Costs appear to be allocated more equitably, it is not heavily reliant on the work of volunteers and an organisation such as this could readily be subject to external technical and financial audit. If similar collectives were to become established in other rabbit prone areas, they would provide more opportunities for information exchange, technical advice, training, coordinated rabbit management and economies of scale, even in the absence of public funding.

18. Recommendations

1. *Councils* must act with some urgency to seek regulations, standards or mandatory codes of practice for poisoning programmes to ensure that future rabbit management is not compromised.
2. *To MAF* – an investigation by the Wallaceville Investigation and Diagnostic Centre to better determine the need and potential for refining the cELISA assay.
3. An investigation initiated by *MAF* and led by a populations geneticist, to determine the presence of genetic resistance in feral rabbits and to consider the implications for management.
4. A review, initiated by the *Rabbit Coordination Group* into how to ensure the adoption of successful approaches to rabbit management in the rabbit prone semi-arid lands.
5. To *public good research funders* - the search for acceptable alternative toxins and for more cost-effective approaches to their use in rabbit control should continue as a priority.
6. To *public good research funders* - a review of current knowledge on the potential establishment of endemic species on the most unproductive rabbit prone lands to create sustainable natural ecosystems less prone to damage by rabbits.
7. *Regional or central government* initiatives to address the looming skills shortage for rabbit management.
8. *Central and regional government agencies* must be ready to respond with information, training and technical assistance where landholders initiate collective approaches to rabbit management.
9. *Council* pest management staff at the interface with landholders should be given the support, technical information and professional development required to enable them to fulfil their roles.
10. To *MAF and the councils* - consideration should be given to the creation of a small specialist capability, operating from a broader land management perspective but knowledgeable on RHD and rabbit management, whose role is to promote best practice in all aspects of rabbit management, provide training and well-supported technical information and play a key role in guiding research.
11. To *MAF and the councils* - the 'Rabbit Fact Pack' information resource should now be updated with current information on RHD reviewed by experts able to comment authoritatively on the disease.
12. Better use could be made of some *council* websites to provide comprehensive information about RHD.
13. To *councils and Federated Farmers of New Zealand* - regular field days would allow a 'hands on' exchange between landholders and enable them to keep up to date with best practice in rabbit management in the post-RHD environment.
14. To *MAF and the councils* - subject to any decision on public funding for rabbit control, an investigation may be warranted into whether the Rabbit and Land Management Programme Property Plans were effective mechanisms for 'locking in' the benefits derived from public funds.
15. To *MAF* - there may also be a case for reviewing the effectiveness of the land condition monitoring initiated by the Rabbit and Land Management Programme.
16. The *Commissioner of Crown Lands* should consider the need to take a more engaged and active approach to rabbit management on pastoral leases and confirm his position to lessees and councils.

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Appendix one: Rabbit control techniques

The estimates in Table 14 below are approximate only but provide a guide to the comparative costs of the different rabbit control techniques available in Otago in 2009. The table does not necessarily reflect the views of other councils on the pros and cons of the different techniques. The Marlborough District Council is aware of cases of successful aerial and ground-applied pindone poisoning programmes when rabbit numbers were at high levels but suggests that there 'may be geographical and regional differences in bait acceptability and performance with this method' (Johnson, pers. comm.).

Table 14: Rabbit control techniques and approximate costs
(Source: Otago Regional Council report 2009/083)

Method	Pros	Cons
1080 Carrot -Aerial ~$80/ha	Can be used on all terrain types. Can be used on all infestation levels. Environmentally friendly poison. Very effective. Allows good bait coverage. Low labour costs on large scale ops.	Expensive. Only able to be used in winter. Not suitable where boundaries are critical or irregular. Requires suitable weather for flying. Requires suitable airstrip for fixed wing work, handy to the block. Subject to more stringent MOH and HSNO conditions, particularly around houses, waterways and public areas. Acceptability issues with sections of the general public. Risk of non target deaths (stock, deer, dogs etc.). Requires minimum of 12 hours free of rain after toxic application. No effective antidote for toxin.
Pindone Carrot - Aerial ~$100/ha	Able to be used on all terrain types. Good where public resistance to 1080 exists. Quick return of ground for restocking. Very low risk of non-target deaths. Less stringent MOH conditions for use than for 1080. Low labour costs on large scale ops. Ideal for small landholdings and peri-urban properties. Antidote available for toxin.	Very expensive. Not suitable for high rabbit levels e.g. >MMS 5. Not as effective as 1080. Much longer persistence in the environment and risk of residues in bodies animals/stock who have ingested sub lethal doses. Requires airstrip for fixed wing work, handy to block. Requires suitable weather for flying. Low tolerance to rain. Can only be used in winter. Birds susceptible to the toxin.

1080 Carrot -Ground mechanical bait layer ~$65/ha	Allows accurate bait placement around boundaries, housing, waterways, etc. Uses less bait per hectare than aerial. Fewer weather issues during application	Higher labour costs. Not suitable for steeper country or areas with poor vehicle or motorcycle access. Requires good coverage of all habitat areas. Requires a skilled operator to achieve good results. Can only be used in winter. No effective antidote for toxin. Requires minimum of 12 hours free of rain after toxic application.
Pindone Carrot - Ground mechanical bait layer ~$75/ha	Suitable for use on flat to rolling country. Cheaper than aerial carrot. Allows accurate bait placement around boundaries, houses, waterways, etc. Low risk of non-target deaths e.g. low toxicity to domestic pets. Quick return of ground for restocking. Ideal for small landholdings and peri-urban properties. Antidote available for toxin.	Very expensive. Not suitable for steeper country or areas with poor vehicle or motorcycle access. Not suitable for high rabbit levels. Longer persistence in the environment. Low tolerance to rain. Requires a skilled operator to achieve good results. Not as effective as 1080. Winter only method. Birds susceptible to toxin.
1080 Carrot -Ground hand laid ~$85/ha	Suitable for use around small infestations. Able to be used on all terrain types.	Not suitable for large scale infestations. High labour costs. Difficult to achieve good coverage on rough or scrubby terrain. Winter only method. No effective antidote for toxin. Requires minimum of 12 hours free of rain after toxic application.
Pindone Carrot – Ground hand laid ~$95/ha	Suitable for use around small infestations. Able to be used on all terrain types. Able to be supplied to landowners- no licence required. Low risk of non-target deaths e.g. low toxicity to domestic pets.	Not suitable for large scale infestations. High labour and toxin costs. Not as effective as 1080. Persistence issues for environment. Winter only method. Birds susceptible to toxin.
1080 Oats Aerial ~$80/ha	Suitable for all terrain types. Suitable for all infestation levels. Fits in well with pastoral grazing management. Quicker return of land for restocking than carrot. Environmentally friendly poison.	Expensive bait and operation costs. More bait preparation required. Not as effective as 1080 carrot. More stringent MOH conditions. Requires minimum of 12 hours free of rain after toxic application. No effective antidote for toxin. Restricted to late

		summer/autumn only. Rabbits can be fickle to eating oats. Bait preparation time and equipment required is greater than for carrot.
1080 Oats – Ground mechanical bait layer ~$75 hand laid ~ $85	Suitable for smaller infestations on flat to rolling ground. Suitable for all levels of rabbit infestation. Quicker restocking than carrot. Able to be used in late Summer/Autumn. Environmentally friendly poison.	Expensive bait costs. Expensive labour costs. Requires a skilled operator to achieve good results. Bait preparation time and equipment required is greater than for carrot. Requires minimum of 12 hours free of rain after toxic application. No effective antidote for toxin. Restricted to late summer/autumn only. Rabbits can be fickle to eating oats.
Fumigation with Magtoxin or Cynogas ~$45/ha ~$0.80/warren/burrow DIY	Suitable for all terrain types. Able to be carried out at all times of the year. Suitable for unskilled staff. Effective if done systematically and followed up. No destocking of land required. No risk of non-target deaths.	Only suitable for small scale operations. High labour costs. High fumigant costs. Needs to be done thoroughly to be effective. Best done as a follow-up to or in conjunction with other control work. Not effective when MMS >4.
Night-shooting, Motorcycle or Portable MC ~ $4/ha Small lifestyle block ~ $150 Portable ~ $10/ha	Effective if done correctly and regularly. Suitable for flat to rolling country with good motorcycle or vehicle access. No destocking of land required. Can be done at any time of the year.	Requires skilled operator to be effective. Not suitable for large scale infestations or steep terrain. Must be done regularly and thoroughly. Not effective when MMS >4 or 5.
Dog and Gun Small lifestyle block ~ $200	Effective on small pockets of rabbits in cover where poisoning, shooting or fumigation are not an option. Can be done at any time of the year No destocking of land required. Enjoyable activity.	Requires a skilled operator and good dogs to be effective. Not suitable on large scale problems or extensive areas of scrub or cover. Not effective when MMS >4.
Day Shooting ~ $10/ha	Good for removing small numbers of rabbits that are not able to be controlled with other methods.	Limited effectiveness. Requires a skilled operator to be effective. Not effective when MMS >4.

Small lifestyle block ~ $150	Can be done at any time of the year. No destocking of land required.	
Trapping Cost extremely variable Small lifestyle block ~ $200	Good for removing small numbers of rabbits that are not able to be controlled with other methods. Can be done at any time of the year. No destocking of land required.	Limited effectiveness -best done in conjunction with other methods. Not effective when MMS >3. Requires a skilled operator to be effective. Domestic pets are at risk. Viewed as in-humane by general public and SPCA. Labour intensive.
Helicopter shooting ~$15/ha/yr	Only effective method where coverage with a vehicle or M/C is limited due to terrain etc. Effective where vegetative cover harbours rabbits requiring the animal to be flushed out using helicopter. Very effective method with skilled shooters and pilots. Can be done at any time of the year. No destocking of land required. Best results when complimented with other control methods.	Only effective if rabbits levels below MMS 5. Relatively costly e.g. ~$15/ha /yr (maintenance control only). Requires assistance from other methods or the regular presence of RHDV.
Pindone pellets $30/ha $20/ha DIY	No licence required when applied in bait stations. Low cost method. Use all year. Suitable for small holdings. No destocking of land required. Low risk of non-target deaths e.g. low toxicity to domestic pets. Antidote available.	Low rates of acceptance in Central Otago. Suitable for low rabbit infestations only. Risk to passerines eating crumbling bait.

The costs in the table above are approximate. They can vary due to the size of the block or land involved, rabbit densities, distance from depot, terrain and changes to estimated costs for materials such as poison, bait and fuel.

Appendix two: Federated Farmers Press Release
Rabbit resurgence big headache for farmers

RELEASED 27 MAR 2009

‘The recent resurgence of rabbits threatens New Zealand's productivity and environment and must be halted as a matter of urgency,’ says Donald Aubrey, Federated Farmers pest animal management spokesperson.

A delegation of Marlborough high country farmers met with the Ministers of Biosecurity, Conservation and Lands to seek Government support for rabbit control in the country's worst-affected areas.

‘The Government must accept its role in protecting the environment, especially rabbit-prone properties in the South Island High Country to ensure the land rehabilitation gains following the introduction of Rabbit Haemorrhage Disease (RHD) in 1997 are not lost.

‘Prior to its introduction, farmers struggled to overcome burgeoning rabbit populations. The value of RHD can not be over-stated. It has enabled an enormous recovery following the extensive damage caused by rabbits and could well be described as New Zealand's greatest conservation gain. Farmers and the Crown have both benefited enormously.

‘By acting in conjunction with farmers, these gains can be maintained. The opportunity to act jointly will ensure environmental values are protected including water and soil values, as well as the lands' productive capacity.

‘Rabbit control should not be the sole responsibility of the landholder. We are more than happy to play a leading role in rabbit control. However, where control costs become excessive, it is appropriate that the public pays a share of these costs,’ Mr Aubrey continued.

Federated Farmers is calling for the establishment of a voluntary group in each area to form an autonomous board to manage the rabbit problem.

The board would oversee infrastructure including the contract growing of carrots, streamlining resource consents, establishing best practice methodology, assisting with further research and development into biological control and liaising with regional councils.

Under the National Pest Management Strategy framework, a formal partnership between landholder and central government should also be formed for a 50/50 split on costs on a property by property basis. This would occur where notices of direction have been issued by regional councils when rabbit numbers reach excessive levels,’ Mr Aubrey added

‘Rabbit numbers have surged as the pest eat and breed incessantly. A pair of rabbits will breed every six weeks producing an average of five to six offspring. It is not uncommon for one doe to produce 45 offspring in one year and these offspring are able to breed at 12 weeks of age.

‘Between 10 and 12 rabbits eat the equivalent of one sheep in vegetation, devouring emerging shoots, denuding the ground and killing off natural cover.

‘The rising number of rabbits demands an urgent solution to prevent further damage to the economy and environment,’ concluded Mr Aubrey.

Appendix three: Federated Farmers proposal to Government

RESURGENCE OF THE RABBIT PEST

- At the time of the application for the introduction of RHD it was estimated that rabbits were costing the country $50 million in lost production plus a further $25 million in direct pest control costs.
- RHD arrived in this country in 1997 and had an immediate effect. There was a 70% decline in the rabbit population (MAF BNZ figures). This contributed to a renaissance of natural biodiversity in denuded areas as well as vastly improved productivity. **It is imperative that the country does not allow this progress to dissipate.**
- RHD was never regarded as the "silver bullet". It is one tool in the ongoing battle to control rabbits and as its efficacy declines through immunity build up it is essential that other effective control measures be applied.
- RHD-immunity was always expected. Now becoming particularly evident in inland areas of Marlborough, Canterbury and Otago. Some 90,000 ha. are now subject to notice under Regional Pest Management Strategies. Control cost for this amount of land could be in excess of $6 million.
- Some landholders struggling to cope with this cost (>$100K in some instances). If the situation worsens control costs could prove uneconomic from the productivity perspective. Land abandonment would exacerbate the problem.

Proposal

- Establishment of a voluntary group in each area to form an autonomous Board based on geographic boundaries for service delivery in managing the re-emergence of the rabbit problem.
- Under the National Pest Management Strategy framework establish a formal **partnership** between landholders' representative Boards (+Regional Councils) and Central Government for a 50/50 split on costings on a property by property basis where notices of direction have been issued. *(Note that this does not necessarily incur extra expense on Government if all parties – including the Crown - involved in land management participate in the scheme)*

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RESURGENCE OF THE RABBIT PEST

PREFACE

An out of control rabbit population is detrimental to the environment, our natural biodiversity and productivity. New Zealand first recognised this in 1867 with the passing of the Rabbit Nuisance Act. Various other measures have been introduced in the intervening time but, it could be argued, have not been fully effective because they have been changed when the pest problem was "almost" overcome. **We do not want Rabbit Haemorrhage Disease (RHD) to join this list of casualties. "Almost" is not good enough to overcome the rabbit problem.**

RABBIT FACTS

The reason for any resurgence in numbers is clear: A rabbit eats and breeds incessantly. A pair of rabbits will breed every 6 weeks producing an average of 5-6 offspring. It is not uncommon for one doe to produce 45 offspring in one year and these offspring are able to breed at 12 weeks of age.

Between 10 and 12 rabbits will eat the equivalent of one sheep. They will eat emerging shoots and denude the ground -- killing off natural cover. At the time of the application for the introduction of RHD it was estimated that rabbits were costing the country $50 million in lost production plus a further $25 million in direct pest control costs.

RHD arrived in this country in 1997 and had an immediate effect. There was a 70% decline in the rabbit population. This contributed to a renaissance of natural biodiversity in denuded areas as well as vastly improved productivity. However, RHD was never regarded as the "silver bullet". It is one tool in the ongoing battle to control rabbits and as its efficacy declines through immunity build up it is essential that other effective control measures be applied.

Rabbit control should not be the sole responsibility of the landholder. They were not introduced by the landholders and their control is in the public interest as described above. Landholders, generally, are more than happy to play a leading role in rabbit control. However, where costs become excessive, it is equitable for the public to pay a share of control costs.

RECENT DEVELOPMENTS

- RHD-immunity was always expected. Now becoming particularly evident in inland areas of Marlborough, Canterbury and Otago.

Marlborough

- In the Awatere no notices of direction were issued 3 years ago. Rabbit incidence levels were at 2-3 (McLean Scale. PMS Limit 4 – elsewhere in Marlborough 3) Since then 11 notices have been issued covering 13,300 ha. Levels recorded at 5-6 some reaching 7
- Sunny faces of one 580 ha. block are now back to pre RHD numbers
- Blood testing has shown >55% resistance to RHD

Canterbury

- Regional Council reports advise of increases in the Mackenzie Basin, Ashburton and Amuri districts.
- 30 directions were issued (McLean scale 3) 2 years ago. The total number of properties now subject to direction is over 100 covering some 26,000 hectares. 26 of these properties (11,000 ha.) are on the verge of being issued with "Action on default" notices.

Otago

- ORC has recently changed its maximum allowable limit (MAL) in Central Otago from McLean Scale level 5 to McLean Scale level 3. It is estimated that this will increase the amount of land subject to direction to >50,000 ha.

Estimated cost of a control operation;

circa. 90,000 ha @ $70 = $6.3 million

(Note that this is a "worst case scenario". The rate of $70 has been used allowing for the difficult terrain of many of these areas)

OTHER FACTORS

- The concentration on Tb vector control has led to a decrease in predators which, in turn, is exacerbating the explosion in rabbit numbers
- Cost delays and resources of obtaining resources consents. Regional Councils report frustrating compliance requirements being applied by ERMA – e.g. screening requirements will make a 20 tonne operation become a 25 tonne operation and add approx $2,000 to operational costs
- The rabbit Co-ordination Group and other agencies are looking into research (e.g. Re-set experiments) to determine best (control) practice. However, these could take 2-3 years to effect. **Action is needed NOW to ensure the problem does not get out of control in the meantime.**
- Some expertise in rabbit control has been lost during the years RHD was universally effective

CASE STUDY

- Leasehold property of 7,000 running 3,000 stock units
- 45% (3,150 ha.) traditionally rabbit prone
- Control at $40 ha. = $126,000 (or $42/su)
- Assuming a 5 year efficiency of poison, this equates to $8.40/su/annum
- Add to this a rent increase in line with current LINZ policy of approx. $14/su/annum (7,000 ha @ $6.00/ha)
- Total additional costs equate to $24.40/su/annum

IS THIS SUSTAINABLE?

If the landholder cannot afford to stay on the land, what then?

RECOMMENDATION - ONE PROPOSED SOLUTION

- Establishment of a voluntary group in each area to form an autonomous Board based on geographic boundaries for service delivery in managing the re-emergence of the rabbit problem.
- The Board would oversee the infrastructure including:
  - Contract/bulk procurement of all on-ground and aerial resources
  - Organising operational application
  - Streamlining resource consents
  - establishing best practice methodology
  - Pooling of knowledge and resources
  - Assist with further R & D into biological control
  - Liaison with Regional authorities.

  (Note that Regional representatives on the Rabbit Co-ordination Group have indicated that they would be able to offer in-kind support to such a structure)

- Under the National Pest Management Strategy framework establish a formal partnership between landholders' representative Boards (+ Regional Councils) and Central Government for a 50/50 split on costings on a property by property basis where notices of direction have been issued. *(Note that will does not necessarily incur extra expense on Government if all parties involved in land management participate in the scheme)*

Protocol

- Government to recognise that the rabbit is a pest of national significance
- Participation by landholders requires them to act on notices of direction
- Role of Regional authorities will be in the monitoring and issuing of notices of direction; auditing of financial efficiency to the Board and central Government satisfaction
- Budgeting of funds will be collated in the preceding financial year in line with direction notices

CONCLUSION

This proposal:

- Is an acknowledgement by the Crown of its responsibilities to the environment detailed in its "Objectives for the South Island High Country"
- Is a method of ensuring that the land rehabilitation gains post-RHD are not lost
- Recognises that effective rabbit control is a benefit to the nation as a whole from environmental and economic perspectives.
- Protects the financial viability of rabbit prone properties

S.I. Rabbit Infestation Status by Region

Marlborough

Direction issued at McLean scale 4 for Awatere – 3 Elsewhere

Directions issued	2 years ago	0
	Last year	5
	Current year	6

Total land area subject to direction 7,041 ha

Tasman

Describes itself as "one of the luckier areas. No Problems at this stage

Canterbury

Direction issued at McLean scale 3

Directions issued	2 years ago	30
	Last year	68
	Current year	45

Total land area subject to direction – 109 properties 26,000 ha
of these 26 properties (11,000 ha.) are on the verge of "Action on default"

Significant increases in the Kurow, Kaikoura, Waikari and Amuri areas

Otago

(Prior tp 2008) Direction issued at McLean scale 3 (coastal) to 5 (Central)

Total land area subject to direction 10,700 ha
(All but 340 ha. In Central Otago – MAL 5)

In 2008 a revised Otago Region PMS became effective. It is anticipated that this will cause the amount of land subject to direction to increase to 50,000 ha.

Southland

Direction issued at McLean scale 4 for Te Anau – 3 Elsewhere

Directions issued	Current year	1

Total land area subject to direction 200 ha

N.B. Eastern coastal areas report lower incidence of rabbit problems and the RHD still appears to be effective

43,941ha @ $70 = $3,075,870 83,241 ha @ $70 = $5,826,870

Question: Is Government prepared to invest between $1.5 million and $3 million p.a. to help protect the South Island Hill and High Country environment?