Possum control by the Department of Conservation

Background, issues, and results from 1993 to 1995

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Published by
Department of Conservation
PO Box 10-420
Wellington, New Zealand

ISBN 0–478–01950–5

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Cataloguing in Publication
Parkes, John P.
Possum control by the Department of Conservation : background, issues, and results from 1993 to 1995 ? John Parkes, Alan N. Baker and Kris Erisksen, Wellington, N.Z. : Dept. of Conservation, 1997.
1 v. ; 30 cm.
Includes bibliographical references.
ISBN 0478019505
1. New Zealand. Dept. of Conservation. 2. Trichosurus vulpecula––Control—New Zealand. I. Baker, Alan N. (Alan Noel), 1940– II. Ericksen, S. K. F. (Sven Kristian Frederick) III. Title.
632.6920993 20
zbn97–085206

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1. Summary

1.1 PROJECT

In 1996 the Land Protection Division of the Department of Conservation was requested by the Director-General to prepare a summary of the background to the planning, conducting, and outcomes of the Department's possum control operations since funding was significantly increased in 1993. This review was prepared by John Parkes, Alan Baker and Kris Ericksen.

1.2 OBJECTIVES

The objectives were to:

- Describe the planning framework used by the Department to maximise the conservation outcomes of possum control
- Summarise what has been achieved in possum control since 1993 in terms of outcomes, costs, successes, failures, and problems of control action, the policy and organisational issues raised, and in research
- Relate these planning and operational outcomes to issues raised by the Parliamentary Commissioner for the Environment in her 1994 report on possum management
- Note what needs to be done in the future to ensure better results

1.3 MAIN FINDINGS

- Since 1990, the Department has been developing a quality management system to manage possums by producing a national plan. It is now working towards developing Quality Conservation Management (QCM) standards and procedures to cover prioritising actions, planning procedures, best practice methods, and monitoring and reporting procedures.
- Results of possum control do not become immediately visible, but in those areas where controls were carried out a number of years ago, (e.g., Kapiti Island, Rangitoto Island, Mapara, Mt Taranaki) the response of native vegetation and bird breeding success has been spectacular.
- Aerial application of toxic bait remains socially contentious and constant vigilance is required with the use of all toxins, particularly the use of aerial 1080. It is imperative that the Department enforces best practice and seeks on-going improvements to minimise non-target impacts on native species and risks to livestock and humans.
- The Department has invested about $700,000 per annum in research on possums (about 11% of the national research investment). Research on maintenance control tactics and strategies is increasing in importance.

2. Background to current possum control

Possums were liberated in New Zealand to establish a fur industry from at least 464 liberations made between 1858 and 1922. They were given various degrees of protection as their benefits (from furs) and costs (to production and conservation) were debated. The view of possums as pests gained ascendancy in 1946, after which all protection was removed. Possums currently occupy about 95% of the country and exist on at least 13 islands. (Further detail on this is available in the Department's National Possum Control Plan 1993–2002).

Since Commercial exploitation of possums began in 1921, over 56 million skins have been exported (Figure 1). In recent decades, the size of the annual harvest of possum skins has been largely determined by the state of the fur market and the price paid for skins (Figure 2). The conservation benefits of these harvest are discussed in section 3.4.6.

The first large-scale attempt at possum control was via a bounty scheme that ran from 1951 until 1961. Over 8 million bounties were paid out, at two shillings and six pence per token (this is equivalent to $13 per token in 1995 values in terms of the average wage). The bounty system, however, failed to control possum numbers and during this period possum populations continued to expand (Pracy 1979). Many skins came from "nuisance" possums in prosperous farming and semi-urban areas rather than from areas where possums were critically affecting agricultural production, natural landscape, and wildlife values. A bounty system cannot target government spending on possum control to where it is most needed. Possum now threaten pohutukawa in the Coromandel and Northland because hunters deliberately introduced the pest to

FIGURE 1. NUMBER OF POSSUM SKINS EXPORTED FROM NEW ZEALAND, 1922–1994 (AFTER PARKES *ET AL*. 1996)

those areas when the bounty system was in force in order to have a local population to "farm" (Pracy 1979). In the past, bounty hunters did not reduce possum numbers to the point that disease risks or damage to the natural environment could be sustained at a minimum level. There is no reason to suppose that the results would be different today, if a bounty were offered. A bounty places a value on the existence of possums. There is no incentive to reduce numbers to low levels. With targeted possum control the Department pays for the result—possums reduced to specified levels. Bounties, as a type of generalised control, were paralleled by other Department of Internal Affairs pest control (e.g., against deer), but were eventually abandoned in favour of more focused control in priority areas after administration passed to the New Zealand Forest Service in 1956.

Large-scale possum control, usually aerially-sown 1080 baits, on conservation land began in the 1960s. Initially, the general strategy was to protect the forest canopy by achieving a large initial % kill that would be repeated after a decade or more. This boom–bust strategy is risky because it assumes conservation resources can withstand several years at high possum densities as the population recovers, and that the money will always be available to repeat the operation. The latter, at least, was not always so and control operations for conservation reasons were begun and stopped in a piecemeal fashion until the 1990s.

In 1987, a strategy largely based on aerial sowing of 1080 baits and ground control carried out by fur trappers, was in operation. By 1995, two thirds of the Department's annual possum control operations were ground-based, using a wide range of techniques. The aerial sowing of 1080 baits remains, however, the most cost-effective option for possum control in remote areas or over rugged terrain.

FIGURE 2. THE EFFECT OF MARKET PRICE (1994$) FOR POSSUMS SKINS ON THE SIZE OF THE ANNUAL HARVEST, 1983–1994 (R^2 = 0.42, P, 0.05; AFTER PARKES *ET AL.* 1996)

The Department's efforts to control possums on the land it administers, received a boost in the late 1960s, when possums were implicated as vectors of Bovine Tuberculosis (Ekdahl *et al*. 1970). As a result, MAF and the Animal Health Board began controlling possum in endemic areas, some of which involved land administered by the Department.

The Department of Conservation inherited the piecemeal regional approach to possum control for conservation purposes that had been operating since the 1960s. Between 1987 and 1992, the Department conducted 16 possum control operations covering about 68,000 ha. The decisions to carry out these operations were made at the conservancy level for local reasons, and history has shown that few such operations are sustained. For example, only one of these 16 operations was in an area that had received control in the past (Deception Valley, West Coast).

In 1993, Government increased the funding for possum control by $3 million. This extra funding meant that the Department had to take a national perspective of possum control in order to achieve the best conservation outcomes. The National Possum Control Plan, with its standardised planning procedures and detailed ranking system for potential management units, was the result.

Public concern over control technologies led the Parliamentary Commissioner for the Environment (PCE) to review the need for and method to achieve possum control (Parliamentary Commissioner for the Environment 1994). The PCE review made six recommendations to the Department regarding aspects of possum management, and the Department's responses are discussed under the relevant sections in this report.

3. The Department's planning framework

3.1 PLANNING WITH UNCERTAINTY

The solution to all pest problems involves the management of four interacting factors—a resource of value, the pest that adversely affects it, people who value the resource, and people who manage the pest (ideally those who value the resource). A narrow focus on just one factor (for example, killing the pest) will rarely lead to sustainable solutions, and will certainly fail for complex problems such as those posed by possums.

The Department has attempted to organise its possum control to take account of the complexities involved within a framework of decisions and actions. Pest management requires clearly defined objectives. It requires that managers know what to do to define objectives, know what actions to take to achieve the objectives, and know what the results of these actions were in relation to what they wanted to achieve. The Department's systems for possum management contain all these elements in theory, and all of them to varying degrees in practice. This is because of the constraints and uncertainties inherent in the state of our knowledge about conservation goals and the threats posed by possums, and about the technologies to deal with the pests. The solution has been not to avoid action because of the uncertainties and risks, but to embrace the principle of adaptive management by setting pragmatic goals that are potentially achievable, monitoring results, and changing practices if required—to learn by doing. Success in achieving the initial goals gives the Department options to set more difficult goals when priorities, logistics and new technologies allow. Setting unachievable goals merely to look good excludes adaptive management and ensures failure.

If all these elements are in place possum control has a chance of being efficient, effective, and sustainable, and so can play its role in maximising indigenous biodiversity. If they are not in place or the goals are impractical, the control action will not be sustainable and the benefits ephemeral.

The Department is therefore committed to "best practice" principles in planning, conducting, and monitoring pest control operations. These principles are necessary to:

- Capture "institutional memory" so that the lessons from the past are retained
- Ensure decisions are transparent and defensible even when many factors are uncertain and actions contain risks of failure
- Ensure operations are efficient (a measure of the means) and effective (a measure of the goals). Note: effectiveness requires that the control action be sustained, and to do this managers have to consider the interactions of a wide set of constraints on their management (e.g., physical and topographical constraints, social constraints, biological uncertainties, non-target risks) as well as the cost to apply technologies.
- Ensure accountability with responsibility

3.2 QUALITY CONSERVATION MANAGEMENT

Setting and enforcing standards of "best practice" is only one step required within any quality management system—it's the equivalent of a warrant of fitness for a car. Managers need to be competent (they need a drivers' licence), and trained (they must know the road code), the system must be funded adequately (the car has to have petrol), the technical parts of the system must be integrated with the strategic parts (the engine must work and there must be roads to drive on), and the goals kept in mind (the driver must have a destination otherwise the car should be left in the garage).

The Department is in the process of setting up quality management systems, called Quality Conservation Management, in 10 functional areas including Management Services: Conservation Estate. Pest control forms a large part of this area, and because of the complexity, uncertainties, and risks inherent in pest control a QCM approach is essential to success and sustainability. The publication of the National Possum Control Plan, and the development of guidelines for monitoring possum control operations are the first steps in this process.

3.3 DOC'S GOALS FOR POSSUM CONTROL

The Department is obliged by the Acts it administers to conserve indigenous natural resources, and as many of these are clearly damaged or changed by possums it is obliged to control possums. The general goal then is to protect resources, and one of the ways to do this is by killing possums.

The actual natural resources to be protected are defined more specifically in the process used to rank areas for possum control (in the National Possum Control Plan 1993) and again in more detail in conservancy based operational plans written for all approved control operations.

3.4 STRATEGIC PLANNING

3.4.1 National Possum Control Plan

The Department of Conservation's National Possum Control Plan 1993–2002 (DoC 1994) was developed in 1993 under the provisions of the Wild Animal Control Act 1977. This plan sets out the Department's legal responsibilities for controlling possums, ranks all the operational areas intended for control before 2002, and sets out some of the planning, methodological, and monitoring systems to be used by conservancies.

A primary purpose of the National Possum Control Plan was to allocate the national budgets tagged for possum control for conservation reasons. A ranking system is needed because the annual control budget is sufficient to effectively control possums' impacts over the next decade on only about 17% of the conservation estate, i.e., 13,000 out of 78,000 km^2. Areas are ranked according to the conservation value of either the flora or fauna in the area, and its vulnerability to possums. (*See pages 15–16 of the National Possum Control Plan for details.)*

Areas of the conservation estate such as the Southern Alps are not particularly at risk from possum damage, but it has been estimated that 18,000 km^2 of forested estate is dominated by canopy species under major risk to possums. Table 1 and Figures 3 and 4 take a 'broad-brush' approach, and show risk only for canopy tree species. Risk categories to species such as mistletoes or giant land snails are **not** shown and the proportions need to be measured.

The ranking system used divides all areas of conservation estate with possums (which is almost all of it) into potential management units, scores the botanical or wildlife values present, and weights the score according to a measure of the threat posed by possums. If units with equally weighted scores need to be further ranked, a series of land attributes or management factors are applied.

3.4.2 The NPP–Possum National budgets

Government allocates some pest control money to the Department in a tagged form, and the Department manages this money via a system called National Priority Pool (NPP) budgets. The possum budget has grown threefold since 1990 (Table 2). The Animal Health Board also allocated money, generally to regional councils as contractors, for control of tuberculous possums on the conservation estate via an "externality" fund from Government (Table 2).

The Department allocated the extra NPP–Possum budget of $3.1 million in 1993 according to the priorities developed in the National Possum Control Plan. All of this money went to initial control in new areas. In subsequent years, some of the budget was spent on maintaining the low densities achieved by this initial control and some (a decreasing proportion over time) on initial control in new areas.

Conservancies apply each year for their maintenance control budgets and nominate new areas for initial control. Maintenance control has first call on the NPP budget, and the remainder is allocated to the highest priority new areas.

The PCE recommended (No. 7) that "to improve accountability and transparency the Department should ensure all direct and indirect costs of possum control operations are explicit and publicly available . . ." The Department's finan-

TABLE 1. AREAS OF NATIONAL INDIGENOUS FOREST HABITATS AT FIVE LEVELS OF RISK TO POSSUM IMPACTS IN THE ABSENCE OF ANY CONTROL.

RISK CATEGORY TO CANOPY SPECIES	AREA IN NORTH ISLAND (km^2)	AREA IN SOUTH AND STEWART ISLANDS (km^2)
Potential forest collapse	2447	3051
Major composition change	3637	6806
Major loss of biodiversity	200	1493
Minor loss of biodiversity	2127	11004
No change/unknown	8723	45484

cial system divides expenditure into two categories, output and input expenditure. The output expenditure for possum control covers, for example, materials, fixed price contracts, plant and equipment, vehicle and aircraft hire. Input costs are salaries and wages, capital charges, depreciation on assets, and operating overheads. The present financial reporting system, however, does not easily allow for transparency with the present mix of operational costs and base hours, onto which overhead costs are loaded.

Because of the difficulties of showing the input and output expenditure as transparent figures with possum control operations, the Department is moving (1995) towards being able to show for an operation all the operational expenditure as distinct from overall input/support costs. These input costs can be allocated pro rata back to an individual possum control operation.

3.4.3 National Science Strategy—Possum/Bovine Tuberculosis

National research strategies at both operational and Public Good Science levels to underpin possum control are co-ordinated by a committee appointed by the Minister of Science and Technology. Apart from this co-ordination role, the committee identifies priority research needs, provides an overview of technology transfer, and organises workshops of scientists, managers, and stakeholders. During 1993–1995 the Department was represented on the committee by Mr John Holloway, Director, Science and Research.

Recent workshops of interest to the Department include:

- Possums as Conservation Pests (O'Donnell 1995)
- Biological control of possums
- Improving conventional control techniques (Wright 1966)

TABLE 2. ANNUAL POSSUM CONTROL BUDGETS (IN 1995 $), 1990/91–1996/97.

YEAR	KEY OUTPUT 4.23 BUDGET (NPP–POSSUM)	TASKFORCE GREEN BUDGETS	TB EXTERNALITY BUDGETS
1990/91	$3,000,000	0	?
1991/92	$3,000,000	0	?
1992/93	$3,000,000	0	$4,400,000
1993/94	$6,100,000	$2,000,000	$6,100,000
1994/95	$6,100,000	$2,000,000	$9,800,000
1995/96	$10,500,000	0	$17,000,000
1996/97	$12,000,000	0	$17,000,000

3.4.4 Strategic control options

Pest control managers must specify the strategy intended, i.e., currently for possums, eradication or sustained control.

Eradication

Eradication, the permanent removal of all possums from a defined area, is the favoured strategy. Eradication requires that three conditions must be met: immigration must be zero, all pests must be put at risk, and they must be killed at a rate faster than their rate of increase at all densities. These conditions can be met on smaller islands. Possums currently occur on at least 13 smaller islands and could be eradicated from all but the largest, the main Chatham Island which at 90,000 ha is much larger than our known current ability to eradicate possums.

The Department will not specify eradication in its operational plans unless it is possible and intended. In other words, the Department will not set operational goals that it knows its managers cannot potentially meet. The reasons for this are largely that impossible goals send all the wrong signals to managers whose actions lose focus and are unsustainable (e.g., see Parkes 1993). The Department's commitment to QCM principles also requires focus and practicality.

Sustained control

On the three main islands, possums are virtually ubiquitous and eradication, even in local areas, is highly unlikely. All control and management must therefore be planned to occur into perpetuity. This strategy is true even where possums may be removed from small areas such as habitat islands or fenced peninsulas, because of the certainty of reinvasion and/or the need to sustain a budget to maintain the fence.

The decision to maintain zero possum density management areas should be taken with an understanding of the costs and benefits. While in 1994/95 the national average cost per hectare to the Department of aerial poisoning with cereal baits was $15.50 per hectare, in specific areas costs can be up to $30/ha (Warburton and Cullen 1993) in order to achieve an initial trap catch rate of 5–10%. Surviving possums exposed to baits have several innate and learned behaviours that make them immune from repeated poisonings, and so may need to be killed by other methods, such as trapping or shooting. The lesson from the successful eradication campaign on Kapiti Island is that the costs per % reduction at these low densities escalate so rapidly that it costs as much to get rid of the last 1% as it did the first 99% (Cowan 1992). The consequences of this escalation in costs is that given a fixed budget, fewer hectares can be treated and fewer resources protected. The benefits of success are absolute as the future impacts of possums are removed. However, for many conservation resources we know that it is not necessary to kill all the possums to achieve protection (e.g., for kokako at Mapara) and so any decision to attempt to do so must be made on the balance of the extra costs against opportunities foregone elsewhere.

For mainland populations the usual strategy is to reduce the possum population in an initial control campaign and then apply an ongoing control regime to maintain the benefits. Predicting the frequency and intensity of the ongoing

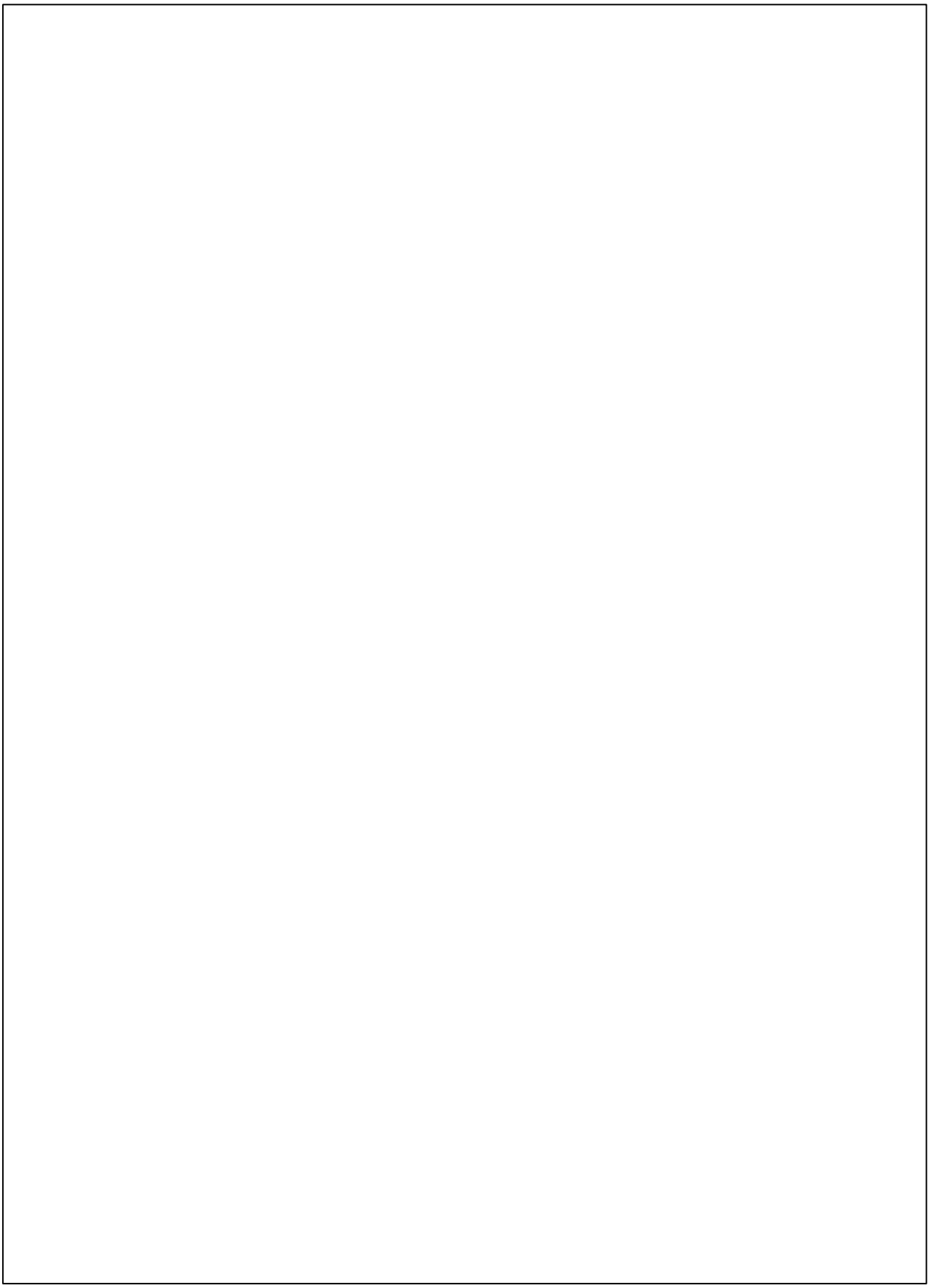

FIGURE 3. BROWSE RISK TO CANOPY TREE SPECIES AMONG THE VEGETATION OF THE NORTH ISLAND.

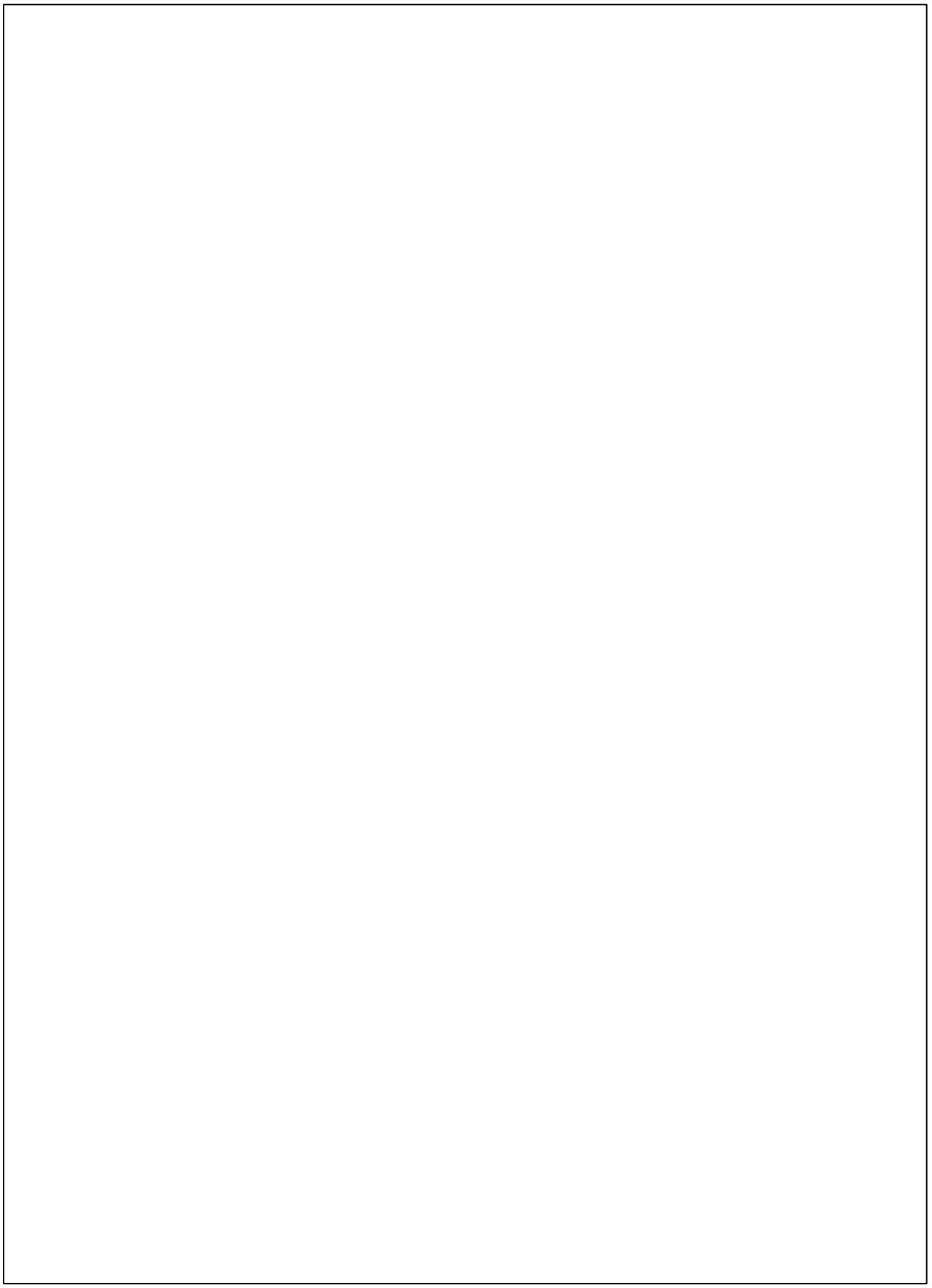

FIGURE 4. BROWSE RISK TO CANOPY TREE SPECIES AMONG THE VEGETATION OF THE SOUTH ISLAND.

maintenance control needed to sustain the benefits of initial control is a difficult task. For sustained control strategies, the "how often" question depends on:

- The relationships between possum densities and their impacts on resources
- The success of initial control operations and the rates at which possum populations recover
- The constraints inherent in the control techniques available to managers (Topography of control areas, people's views, and possum behaviour)

The answer is different for each place, and although managers can apply some models or rules of thumb to decide how often to apply maintenance control, they will need to monitor outcomes and react to circumstances as required. This flexibility, however, is constrained by the need to allocate annual budgets.

Integration with other pest control

In addition to possum control, the Department currently funds control against feral goats over about 10,000 km^2 in about 140 operations, thar over 500 km^2 in two operations, and conducts control, mostly against predators, over small areas to protect threatened species in about 70 km^2 in five "mainland islands". Control of animal pests also occurs in numerous species protection programmes. What co-ordination there is between these operations and their location has been "integrated" by prioritisation of the independent but parallel ranking procedures. If a species protection programme is occurring in an area then possum and goat control will also be funded in that area. If goats occur in an area where possum control is taking place, then this area will receive funding ahead of an equally ranked goat area where possum control is not occurring. The national conservation benefits, however, would be improved by better co-ordination. One process to achieve this has been suggested in the 1995 report "Integrating control of mammalian pests to protect conservation values in New Zealand" (Parkes and Nugent 1995).

3.4.5 Tactical options

Possum managers have a wide range of control tools available, unlike managers of pests such as stoats. However, each control method comes with a set of manageable and unmanageable advantages and constraints that have to be considered, e.g., each technique has different non-target problems, costs, social acceptability, and sustained effectiveness on possums. It is important that the desirable frequency and intensity of control is determined by the possum—resource relationship and not entirely by the constraints on technologies.

The Department has tended to focus on the relative costs of each technique and on the initial control phase of operations (and thus favour aerial poisoning). However, as operations move to the maintenance control phase other advantages and costs will increase in importance and inevitably lead to finer-scale applications of control methods at different locations, frequencies, and intensities determined by the predicted or measured interaction of the conservation values and possums. Modern management tools such as computerised Decision Support Systems and Geographic Information Systems will play a key role in improving the quality and defensibility of decisions on possum control.

3.4.6 The conservation role of commercial fur trappers

The contradictions between agencies that see possums as pests and people who see them as a resource (fur trappers) are managed by the Department in its role as manager of the Wild Animal Control Act and as managers of the conservation estate.

There is ongoing contention about the conservation benefits that result from the commercial activities of fur trappers. (Note: we distinguish here between commercial harvesting for fur and the use of ground hunters contracted to reduce possums by an agreed amount, but who may also take the fur from animals killed.)

In a general sense, the national harvest of furs is too small to have any overall conservation benefit. An average of 1.3 million skins have been exported each year since 1983. Assuming 1.5 million possums killed, an intrinsic rate of increase of 0.29, logistic growth, and a starting population of 70 million, such a sustained harvest would result in an equilibrium population of 64.3 million possums—hardly sufficient to protect anything but the most robust conservation value.

Possum hunters tend to concentrate their efforts in the more accessible places, such as bush–pasture margins. It may be that their efforts here do significantly reduce local populations and provide some benefits to conservation values. Conversely, traps and cyanide pose risks to ground-dwelling birds. In general, the Department encourages possum fur trapping, does not expect much benefit from this, and places some restrictions on trapping methods in areas with kiwi and weka.

In areas subject to control operations, the Department has used commercial trappers as contracted ground-hunters for initial control, and places no special restrictions on hunting after the initial operations, although the densities of possums remaining are usually not attractive to commercial hunters.

3.4.7 Use of Task Force Green

Special Task Force Green funds totalling $2 million were available for possum control for each of the 1993/94 and 1994/95 years.

Approximately 50,000 ha of land received possum control in each year of the scheme. The average operational cost, however, at approximately $37/ha was about twice that of standard annual ground control ($18/ha). Administering these projects also took up substantial amounts of field centre and conservancy office time, and this resulted, in some instances, of other programmed work being deferred.

The government accepted that for subsequent years that the Department should receive these funds unfettered.

3.4.8 Operational practices

In order to maintain consistency among possum control operators, the National Possum Control Agencies Committee suggested a series of manuals be produced covering aspects of control conducted by the Department, Animal Health Board (AHB), and Regional Councils. They were to cover: toxins and poisons (this

would include all vertebrates pest toxins), planning and conducting an operation, and monitoring and reporting.

In light of changes due to the introduction of QCM these 'manuals' will now take the form of standards and procedures as set out by Animal Pest Control QCM. The only exception to this will be the Toxins and Poisons Manual. This is being developed by the Department's LPD (Land Protection Division) and will be published by its Science and Research Division. It will exist as a stand alone reference manual.

As new information or better control methods are developed the QCM standards and procedures will be regularly updated. The new system covers the PCE's recommendations 11 and 12: To develop a public decision making and reporting protocol, and to revise protocols and manuals for the security of poisons.

3.4.9 Co-ordination between possum control agencies

Principles

National policies for possum control are complicated by the dual status of the possum as a conservation pest and as a vector of bovine tuberculosis, and as a pest and a resource to fur trappers. Some policy complications have arisen from the different priorities for possum control on the conservation estate, farmers being interested in areas with tuberculous possums or buffer zones and the Department being interested in areas with the highest priority conservation values at risk. The solutions to this pest duality are:

- The goals of possum control need to be kept clear—with the Department being responsible for possums as conservation pests, and the AHB and landowners responsible for possums as disease vectors. Note: some regional councils fund possum control on or adjacent to the conservation estate in the absence of bovine TB, presumably as a prophylactic measure against TB.
- Funding for the two problems must be transparent—with the externality problem of diseased possums on the Crown's estate being funded by a special grant to the affected landowners via the AHB (see Table 2).
- Where the Department's priorities coincide with the AHB's priorities, the two agencies and regional councils should co-operate tactically for as long as their problems coincide. Note: the AHB's aim is to eliminate TB in vectors and domestic stock after which it would have no interest in possum control at that place. In contrast the Department will have to control possums in perpetuity.

National Possum Control Agencies

Co-ordination between possum control agencies is achieved through an ad hoc group, formed on the initiative of the Department, the National Possum Control Agencies (NPCA). The NPCA consists of representatives of DOC, MAF, AHB, and the Local Government Association with a full-time paid staff of one to co-ordinate supply, control activities, and responses to public issues arising from possum control. Co-ordination at an operational level is achieved at the conservancy/regional council level.

The NPCA was formed in 1993, and since then has undertaken a comprehensive programme:

- Improving public understanding of the possum problem
- Developing resource material on control methods (see references)
- Establishing standards for control operations
- Facilitating operational planning and implementation of training for field staff (DOC and Local Government)
- Ensuring political interests are briefed on possum control programmes
- Providing an interface between researchers and practitioners

The NPCA budget for the past three years has been sourced primarily by contributions from the Animal Health Board and the Department, and supplemented by other contributions from regional councils and MAF.

3.5 OPERATIONAL PLANNING

Conservancy pest managers are required to write a detailed operational plan for each management unit for which funding is approved. An operational plan describes in a standard format the area to be treated, reiterates the ranking justifications, specifies what initial control is intended, specifies what operational and performance monitoring is intended, notes any potential non-target problems, outlines the consultation process to be followed, and predicts what maintenance control regime will be required.

A standard format for operational plans is given in the National Possum Control Plan, Part 2 Sec. 4.2, Contents of an Operational Plan. The operational plan also contains a checklist of actions and events that must be signed-off by the relevant conservancy officer.

3.6 CONDUCTING AN OPERATION

3.6.1 Staffing and training

Currently staff training is done “on the job”, in a semi-annual post-operational debriefing workshop, and in training workshops organised each year by the NPCA and held around control operations.

Lack of structured training for pest control managers and field staff has been a weakness of the entire possum control industry. Over 1995 the Department developed an animal pest control training module as part of its overall Ecological Management Skills programme for delivery through tertiary educational institutes such as polytechnics.

Some initial steps were taken by the Local Government Industry Training Organisation (LGITO) to develop a pest management training system as the Industry Training Organisation, but progress was limited. The NPCA is currently promoting the development of a pest management training scheme under the auspices of the New Zealand Qualifications Authority. A potential partnership was envisaged between the department and the LGITO with the potential for the Department’s current training module to be incorporated in this scheme. However given the changes in the structure of LGITO, its ability to deliver training is unlikely.

3.6.2 Contracting

Much of the control delivery for possum operations is contracted out to aerial bait distributors or to ground hunters. Standard contracts are to be developed under the Quality Conservation Management process.

3.7 MONITORING AND REPORTING ON OPERATIONS

The PCE recommended (No.8) that the Department ". . . ensure cost-effective control by:

(a) Developing monitoring guidelines for both operational (residual catch rate) and performance (effect of reduced possum populations on resources) monitoring; and

(b) Allocating funds for monitoring."

The Department has commissioned ongoing research to identify "best practice" operational monitoring methods. These will be incorporated and updated into QCM standards and will be enforced via the Regional Directorates as part of the QCM process which will operate under the new departmental structure (May 1997). The Department also attempts to monitor the response of conservation values to the reduced densities of possums. Vegetation monitoring using a canopy condition index has been developed through Science and Research Division funded projects, but in specific areas other flora (e.g., rare plants) or fauna (e.g., snails or kokako) may be used to monitor success or failure of control operations.

Operational and performance monitoring is budgeted in each control operation, at levels commensurate with the scale of the operation. Generally it is recommended that up to about 10% of the operational budget should be spent on monitoring.

3.7.1 Operational monitoring and reporting

The National Possum Control Plan requires Operations Managers to summarise what they did in an operation using standard formats and best practice methods set out in the protocols.

Basically, the Operational Report describes the area covered, the relative abundance of the surviving possum population, the amount of control effort, the number of other pests or non-target animals killed, and the costs. It has space for explanation if the actions differed from the plan so managers can learn from experience. An operational report is expected to be written soon after each operation is completed.

The PCE recommended (No. 7) that the Department ". . . move to performance-based contracts for all possum control operations." The Department currently insists on "performance" based contracts for all contracted ground control. With trapping and cyanide the contractor is obliged to achieve a specified trap catch rate in the control area. Where bait stations are used the performance standards relate to the contractor meeting specified gridding and baiting regimes for the

bait stations. Aerial contractors' performance contracts are based on requirements to cover a specified area at set sowing rates and with minimal gaps, and penalties may be imposed for lack of this performance.

3.7.2 Performance monitoring and reporting

The effectiveness of control is given in a performance report. No standard format is imposed because each operation is unique, and no timetable for reporting is possible because responses of natural resources to reduced possum numbers are often slow. For this reason, performance monitoring (= change in conservation values) is not suitable to measure the "performance" (= % trap catch rate) of control contractors. (Note: different meanings of the word "performance").

The methods to measure conservation outcomes naturally vary with what is being measured (see section 4.7), but the Department has invested in a large research project to develop an index of browse damage in bio-indicator canopy tree species to give some overall index of success in forest habitats.

4. What has been done?

4.1 RANKING INTENDED OPERATIONS

In 1993, about 720,000 ha of conservation estate (9% of the total DoC estate) were ranked in 238 potential operational areas. The addition of extra funds in 1995/96 allowed an extra 300,000 ha of new areas to be added to the list for control. This section of the review summarises what has been achieved to date. It also notes in the relevant section the responses made to recommendations of the Parliamentary Commissioner for the Environment (PCE) in her 1994 review of possum control.

4.2 EXTENT OF CONTROL

The Department in the 1993–1995 period initiated over 300 possum control operations. The level of resourcing allocated to the Department, for the 1994/95 year have allowed a maximum of 1,300,000 ha to be managed on a sustained basis. If higher intensity control is required, or costs increase, then a lesser area will be able to be sustainably managed. Subsequent Green Package announcements will allow greater areas to be sustainably managed.

4.3 CONSULTATION PROCEDURES

The Department knows that its pest control operations will not be sustainable unless it has wide agreement on the goals to be achieved and on the means to achieve them.

The Department has conducted only minimal consultation at a national level on its goals for possum control and on the ranking procedures and selection of areas for action. This is mostly because the time available between indicative Budget allocations (February/March) and the need for control action (autumn) precluded any substantial consultation with interest groups. Some key stakeholders, however, were invited to the decision-making meetings in 1993.

Consultation on goals at conservancy levels has been more substantial and ongoing as part of the whole prioritisation process for Conservation Management Strategies. This input has automatically fed through into the national system because it is determined from the bottom up, not imposed by Head Office. However, in 1994 the Land Protection Division of Head Office issued a public relations and consultation document to assist conservancies.

In New Zealand, possums are pests and should be controlled. However, there is no consensus on how this should be done and there is an urgent ongoing need to maintain a flow of relevant information, particularly on 1080, to the public and to specific interest groups and tangata whenua.

4.3.1 Consultation with Maori

The PCE recommended the Department "improve consultation with tangata whenua".

The Department recognises Tangata Whenua as more than just an "interest group", and that the Resource Management Act and the Conservation Act requires that the Department give effect to the principles of the Treaty of Waitangi. Putting this recognition into practice with respect to possum control has proved a demanding task for the Department, but one it is determined to follow and improve. Internally, the Department relies on its Kaupapa Atawhai Managers to advise Operations Managers on appropriate methods and levels of consultation with iwi and hapu. Externally, the Department has routinely held hui with iwi and hapu in whose rohe operations are planned, and where possible modifies the way operations are conducted to satisfy Maori concerns.

The Department notes six issues that affect its consultation with Maori:

- There is little consensus among Maori over appropriate methods of control (e.g., some tangata whenua supported and other opposed aerial poisoning of Mt Karioi at a public meeting in Raglan in 1994).
- Choices on methods of possum control are often constrained by the physical nature and size of the land to be treated. The Department needs to be careful to demonstrate this and not just assume it is obvious to others (e.g., Te Roroa initially gave reluctant approval for the use of aerial poisoning at Maunganui Bluff when they were shown the inaccessibility of the area to ground-based hunters).
- If sufficient time and resources are not allocated to ensure effective consultation with iwi during the planning stage of a possum control operation where they are affected, the outcomes and ongoing sustainability of operations could be compromised.
- The Department has sometimes got caught up in arguments among iwi, hapu, and whanau over issues of who should be consulted (e.g., problems arose in a proposed control operation in Russell Forest when only one hapu of Ngati Hine was consulted).
- The employment of local people is often raised as an issue when aerial control is proposed. For example, local opposition to aerial control of possums in the Maungataniwha forest in Northland in 1995 resulted in serious physical protest. Besides unemployment, this protest involved issues connected with consultation and fear of the 1080 toxin, exacerbated locally by Ten-eighty Action Network New Zealand (TANNZ) members from outside the region.
- Issues of the damage caused by possums versus the ways of controlling them on the wairua of the land have been raised by some Maori (e.g., some people in Taranaki saw the possums as the main culprit affecting the spiritual values of their mountain while others were more concerned about the appropriateness of the means of dealing with the possums).

The extensive consultation conducted in East Coast Conservancy during 1995 is a model the Department should follow. The Kaupapa Atawhai manager and the conservancy Wild Animal Control officer (both Maori) held hui at 23 marae, i.e.,

the level at which consultation is made needs to be at the marae or hapu level, to explain the Department's problems and proposed solutions. Key kaumatua were flown over the areas to be treated and shown the problems caused by possums and the scale and difficulty of access. All hui but one approved in general the Department's plans.

A meeting of Maori Landcare Research staff and Department officers in March 1996 identified the need for technical information on control methods, their use, and on the benefits and risks of possum control to be provided to Kaupapa Atawhai managers and so to Maori considering control proposals in their rohe. In the latter case, the technical information needs to be imparted in person at an appropriate level (see the East Coast experience above), and there should be advantages in some areas if the information can be provided by people independent of the Department, i.e., where DoC staff are seen as having a vested interest in the outcomes. The Department must therefore accept this aspect as an additional cost to achieving the desired outcomes—a cost not normally associated with bovine TB operations carried out by regional councils.

4.3.2 Consultation with other stakeholders

General meetings have been held each year between the Director, LPD, and the Manager IAP and the Conservation Director, Royal Forest and Bird Protection Society, where possum control has been an agenda item.

Generally, the Department has strong on-going support for its possum control programmes from Forest and Bird and other conservation groups. This is particularly the case with the aerial use of 1080.

Various discussions have been also held with the New Zealand Opossum Fur Producers Association, mainly to work through difficulties the fur trappers have with the Department's rules on the use of traps and cyanide in areas with threatened ground birds (kiwi, weka).

The anti-1080 action group TANNZ met with Departmental representatives on two occasions during 1995. These meetings helped clarify positions, identify misinformation, and assisted in developing communication pathways, but did little to change the views of the action group.

Occasional meetings are also held with the New Zealand Deerstalkers' Association executive. The NZDA, at a national level, remains implacably opposed to the use of aerial poisoning in areas with deer. This puts strain on the relationship between the Department and NZDA.

4.4 CONTROL USING AERIAL 1080 BAITS

Aerial application of cereal or diced carrot baits with 1080 toxin is clearly the most efficient method for the initial reduction phase of possum control, particularly over large areas or in areas where access on foot is difficult. Reductions of possum populations to a residual trap catch rate of about 5% are expected at costs between $15 and $30/ha. (On an annualised basis this is about $8/ha if control is required every four years).

Whether repeat aerial poisoning is the most efficient and effective method for the ongoing maintenance phase of possum control is arguable and depends on the frequency of control needed to protect particular resources. Too frequent use of 1080 may lead to bait or toxin avoidance problems in possums, and the Department has invested in research on the feeding behaviour of possums in attempts to avoid learned bait/toxin aversion developing.

There has been considerable public opposition to the aerial use of 1080 that will compromise the sustainability of many control operations unless managed carefully. The PCE concluded that ". . . current evidence on the environmental and human health effects cannot prove absolute safety, but the risks of using 1080 are acceptable in relation to the benefits of use."

All aerial 1080 operations are subject to approval by the local Medical Officer of Health who, operating under the Pesticides (Vertebrate Pest Control) Regulations 1983, considers each operational plan and may set conditions on the operation. The Ministry of Health has produced a set of guidelines for Medical Officers of Health. A number of territorial authorities also require resource consents before operations can proceed.

The Department continues to research and reduce risks as a matter of course, and intends to continue to use 1080 both in aerially-sown and ground baits where appropriate as part of the mix of control techniques available. The costs of not using the most efficient control techniques are that fewer resources or conservation values can be protected.

The PCE recommended the use of differential Global Positioning Systems (GPS) for all aerial poisoning operations to improve bait coverage (Recommendation no. 9). The Department had in fact pioneered the use of GPS positioning some years earlier with immediate real savings in costs and impacts through decreased bait/poison loadings being possible with more accurate positioning and more complete coverage. The Department has invested in research and monitoring of bait coverage using GPS to improve the achievement of the target residual trap catch rate and allow lower bait sowing rates to save money and reduce non-target risks.

AREA TREATED BY AERIAL 1080

	Initial control (ha)	Maintenance control (ha)
1993/94	94,000	1300
1994/95	112,000	1900

The PCE recommended that the Department phase-in the use of differential global positioning systems (GPS) for all aerial control operations, i.e., to improve bait coverage.

The Department has favoured aerial contractors with GPS since 1993, and used them in many of its aerial operations in 1995. The majority of contractors available to do this work have now invested in the substantial sums required to meet the Department's preference.

4.5 CONTROL USING GROUND-BASED METHODS

PCE's Recommendation 10:

"To promote possum hunting performance contracts by:

(a) including instructions for such contracts in staff training manuals

(b) comparing contract ground hunting with current control methods; and

(c) developing standards for contract hunting."

Departmental response:

AREA TREATED BY GROUND CONTROL		
	Initial control (ha)	Maintenance control (ha)
1993/94	120,000	54,000
1994/95	73,000	84,000

About 70% of the area covered by current control operations used ground control techniques, with contract hunters used where appropriate to do this work. Contracts for hunters need to be reviewed, both to provide standardisation throughout the department's operations and on the basis of performance, i.e., identifying what goals can be achieved for what costs. Under the QCM codes of practice on standard operating procedures, contracts should set a minimum level of performance objectives to be achieved by the contracted hunter within a defined budget. These should be based on residual levels rather than proportionate reductions.

The Department and the Animal Health Board commissioned Landcare Research to compare costs and percent kills of contract ground hunters and aerial poisoning in two areas (the Kaweka Range and the Owen/Matiri). Results are pending.

4.6 OPERATIONAL MONITORING AND REPORTING

4.6.1 Catch rates

The Department generally uses the trap-catch method to measure the relative abundance of possums after control for most control operations. The "best practice" method for this technique has been recently updated (Warburton 1996) and recommends the use of Victor No. 1 unpadded leg-hold traps. Use of these traps in areas with kiwi or weka must follow current DoC safety procedures and consequently the method may not be suitable in such areas.

An analysis of 22 departmental aerial operations monitored by trap catch, plus 22 regional council operations monitored by "other" methods showed an average of 88% ± 3% reduction in possum numbers. Few managers reported the precision of their estimates, and were apparently reluctant to report failed operations. The use of Global Positioning Systems (GPS) to ensure better bait distribution and of fixed-wing aircraft significantly decreased the residual trap catch rate achieved (Brown and Arulchelvam 1995).

4.6.2 Monitoring the impacts of control techniques on non-target species

All possum control techniques pose some inherent risk to various non-target animals but in general the benefits of possum control are considered to outweigh these risks in the long term. This balance is more specifically improved by appropriate use of techniques, i.e., by avoiding some methods in some places, and by research to modify control methods to reduce the risks and by maintaining bait and operational standards.

Protected species

The Department has concentrated on monitoring rare animal species by fitting these animals with radio-transmitters before the area is poisoned and tracking them to measure survival after they have been put at potential risk.

- **Kaka** 21 from the Hauhungaroa Range all survived the control operation
- **Blue duck** 19 from the Hauhungaroa Range all survived the control operation
- **Great spotted kiwi** 9 from Gouland Downs all survived the control operation
- **Brown kiwi** 24 from Aponga Reserve all survived the control operation.
  22 from Rewarewa all survived the control operation.
  14 from Northland all survived exposure to ground-laid 1080 jam baits.

Research is currently underway to test possible risks to short-tailed bats and native frogs.

In one operation, at Waiau Falls on the Coromandel Peninsula, the use of 1080 had no adverse impact on either Hochstetter's or Archey's frogs.

Invertebrates are also potentially at risk from 1080. However, field trials have shown no significant differences in numbers or seasonal fluctuations of any invertebrates after aerial 1080 poisoning in a trial conducted in 1992/93 at Titirangi Scenic Reserve. As with birds, some invertebrate taxa (including earthworms, tree-weta, and cockroaches) were too infrequent to be adequately monitored in this trial. Other studies on risks to invertebrates have proved inadequate to measure effects, but the Department is currently funding studies to try to resolve some of the outstanding concerns.

Leg-hold traps sometimes kill or injure ground-dwelling birds such as kiwi and weka. The Department does not permit the use of leg-hold traps set below 70 cm from the ground in areas with ground birds.

The Department, Animal Health Board, and Landcare Research conduct ongoing and regular research into the impacts of 1080 on non-target species (including protected species). Endangered birds, including kokako, kaka, blue duck, weka, and kiwi have been extensively monitored through aerial operations, without any negative impacts on their populations. Concern about the possible impact of 1080 baits on populations of robins, tomtits, and moreporks led to a research programme being established at Pureora forest (Spurr and Powlesland 1997). It is generally held that while common species are affected by 1080 poisoning, there is more than sufficient recruitment of new birds through the greater

nesting successes over following seasons as a result of the reduction in predation of the fledglings by rats and possums.

Other pest species

Non-target pests are also killed during aerial control operations although the benefits of these kills are variable.

- **Ship rats** More than 90% of ship rats have been killed in departmental aerial 1080 operations. This gives an immediate benefit to native biota preyed upon by rats but may increase the impact from stoats which increase the proportion of birds in their diet to replace their normal diet of rodents.

  Ship rat populations recover within a few months so any net benefit is soon diminished. However, possum control timed to coincide with the birds' nesting season may allow a pulse of young birds to reach adulthood when they may be less susceptible to rodent predation.

- **Deer** About 30–40% of red deer populations may be killed during aerial poisoning aimed at possums. Generally, this level of reduction will have only minor conservation benefit in forest habitats which require very large % reductions in ungulates before the most palatable understorey species show any regeneration. Deer populations will take several years to recover from such mortalities.

The conclusion is that incidental mortality of deer (and other ungulates such as goats) does not constitute effective control and merely irritates deer hunters and perhaps compromises the sustainability of the main aim of aerial poisoning—the control of possums. If the Department wishes to target deer it should do so for specific reasons and use other more efficient and effective deer control techniques.

4.7 CONSERVATION SUCCESSES—PERFORMANCE MONITORING

The nature of the relationship between possum numbers and their impacts on particular conservation resources is not usually known in sufficient detail to predetermine how often control needs to be conducted. However, our ability to predict outcomes will be improved as more operations are monitored to measure both possum population densities and the responses of biota to the control programme.

Both the response of conservation resources to reduced number of possums and our ability to measure and interpret responses takes time. For some plants improvement is quite rapid, e.g., kohekohe and titoki showed a significant increase in foliage only a year after control in the Otari Native Botanic Garden in Wellington. For others however, response is slow, e.g., no improvement in the condition of five possum-preferred canopy species was detected after five years possum control (achieving a 70% reduction) in the Otira and Deception catchments. It is unclear whether this result is because the time was too short for the plants to respond sufficiently to be detected by the survey methods or because a 70% possum reduction is insufficient to allow any response.

A selection of successes measured during the last few years include:

- The number of *Powelliphanta* snails at Charming Creek (near Westport) declined from about 2000/ha in the mid-1980s to about 120/ha in 1992, but has increased to about 720/ha following ongoing possum control begun in 1992 that has reduced the possum population by about 80%.
- The rare shrub, *Melicytis* "egmont" found as a few individuals on Mt Taranaki has produced a flush of epicormic shoots and lots of seedlings following possum control.
- The numbers of kereru and tui on Kapiti Island more than doubled after possums were eradicated. Kokako fledging rates at Mapara and in Bay of Plenty forests have also increased significantly after possum control—showing that eradication (although desirable) is not necessary to gain some benefits.
- Chatham Island pigeon numbers have increased from 45 to 150 and taiko nests have increased from 1 to 6 in areas subjected to possum and predator control since 1989.
- Possums had removed all adult *Fuchsia excorticata* from the Waihaha area of Pureora Conservation Park, but two years after possum control in 1994 groves of saplings now occur in many areas inaccessible to deer.
- There has been a marked improvement of the condition of toro at Mt Burnett (Nelson/Marlborough). Visible possum browse has decreased to almost nil, and canopy densities have shown about a 12% improvement over two years.

See also the comparative photographs (Figures 5–12) in Appendix 2.

4.8 RESEARCH

The Department currently funds about $706,000 per annum for research on possums, representing about 11% of total investment in possum research (Table 3). This represents about 7% of the total DoC possum control budget. In recent years there has been a shift in research topics driven by the operational need to maintain low possum densities in perpetuity after the initial control operations. Both the tactical research projects and the new strategic research concentrate on maintenance control topics. Research on non-target animals has moved from testing common to rarer species.

4.8.1 Research highlights

Performance monitoring

The Department, via a contract to Landcare Research, has completed a large research project aimed at developing a method to measure the effect of reduced possum numbers on selected canopy tree species. This reflects the need to know whether control actions are sufficient to protect resources and to gain more measures of success of operations, to ensure ongoing public and political support.

- The method will detect both seasonal and annual changes in foliage density and browse damage and has been used successfully to evaluate several small

possum control operations. It is being applied in several research and operational experiments, e.g., in the Matemateaonga Range.

Possum and deer impacts in forests

A number of research projects are underway to measure the effects of herbivores on native forests. A FRST and DoC funded project investigated the relative impacts of possums and deer at Pureora Conservation Park (Nugent *et al*. 1995). Some key results include:

TABLE 3. CURRENT (1995/96) RESEARCH ON POSSUMS FUNDED BY THE DEPARTMENT. Estimated from Possum and Bovine Tuberculosis Control National Science Strategy Committee, Annual report, September 1995.

PROJECT	ANNUAL COST ($ X 000)	PROVIDER	RELATED RESEARCH EFFORT
Control techniques:			$1301.0
(a) Bait feeders	$31.7	Landcare Research	
(b) Pesticides	$36.7	Landcare Research	
(c) Long-life bait	$31.4	Landcare Research	
(d) Poison aversion	$22.0	AgResearch	
(e) Bait aversion	$29.3	AgResearch	
Control strategies:			$556.0
(a) Maintenance control	$47.1	Landcare Research	
(b) Intermittent control	$161.0	Landcare Research	
(c) Target densities	$44.8	Landcare Research	
Impacts:			$540.0
(a) Role in kaikawaka	$20.0	Landcare Research	
(b) Impacts of possums	$32.6	Landcare Research	
(c) Kamahi, Tongariro	$1.5	Massey University	
Monitoring:			$36.0
(a) Effects of control	$86.1	Landcare Research	
Non-target impacts:			$23.0
(a) 1080 on frogs	$2.0	Victoria University	
(b) 1080 on bats	$40.0	DoC S&R	
(c) 1080 on bat food	$19.0	DoC S&R	
(d) 1080 on invertebrates	$2.5	DoC S&R	
(e) Kiwi, possums, toxins	$42.2	DoC S&R	
(f) Morepork, robins	$38.5	DoC S&R	
Social research:			$11.3
(a) Perceptions of 1080	$18.0	Private	
Biological control:	$0		$974.6
Possum physiology	$0		$2523.2
TOTALS	$706.4		$5965.1

- Deer and not possums determine what regenerates in forests. This result (easily demonstrated with exclosures) means that controlling possums alone will not protect forest ecosystems in the long-term.
- Possums ate 102 species of plants. Woody plants, particularly Hall's totara and kamahi, formed the bulk of the diet, although fruit was important at some times of the year. Note: the periodic masts of fruit appear to strongly influence possum condition and survival (Brockie 1992).
- Possums at a low density of about 3 animals/ha, ate only 3.3% of the annual foliage production of about 2.5 tonnes/ha, and are therefore, considered only likely to affect the abundance of Hall's totara in that forest.

New toxins and baits and ways to deliver them

- A new toxin (cholecalciferol) has been tested against possums by Landcare Research with funding from the AHB and is now available in a cereal bait (Campaign®), for use by anyone wanting to control possums. Some advantages of Campaign ® are that it requires no pre-feed, poisoned carcasses pose low risk of secondary poisoning, and is probably less of a risk to non-target animals. Unlike 1080, it is available to farmers. It does, however, cost more than 1080 and additional research is required regarding risks to non-target animals.
- Possums can easily detect cyanide and avoid baits with this toxin after any sub-lethal encounter. Encapsulating the cyanide in a bait that stops the volatile smell escaping is being researched (with funds from AHB and industry) to avoid bait shyness. Success will also allow cyanide baits to be used to monitor the relative abundance of the residual population in control operations and so replace the more expensive and risky trap-catch method as best practice.

Bait shyness

Possums that receive a sub-lethal dose of toxins may develop a learned toxin/bait aversion and avoid subsequent attempts to poison them. For example, three months after an area was baited for rabbits (i.e., with low-dose 1080 baits) 57% of possums refused to eat 1080 baits. These field results have been confirmed by several pen studies done by AgResearch and Landcare Research.

DOC, AHB and FRST have funded several projects investigating the ways possums may avoid toxic baits. Current field trials by Landcare Research aim to design control strategies that will firstly avoid shyness problems and secondly mitigate it if it does occur. Experiments are being conducted to compare shyness by switching from acute toxins such as 1080 to chronic ones such as brodifacoum during subsequent control, or by retaining the use of the acute toxins but switching the bait or lure used.

Bait delivery

- The use of GPS to ensure complete bait coverage during aerial control of possums has improved kill rates and allowed large reductions (from about 20 kg/ha to below 5 kg/ha) in bait densities—with no loss of effectiveness and a large decrease in cost. New procedures for identifying and plotting operational boundaries using GPS were introduced in 1995 to reduce the chance of aerial

drops being off-target. Landcare Research has also developed a prototype bait-disperser bucket that will allow consistent low-density bait dispersal.

- Results from trials using 1080, Talon®, and Campaign® in bait stations continue to improve the efficiency and effectiveness of this control method. The Department has used bait stations as an initial control technique in Waikato Conservancy, but its main use is probably as a maintenance control method.

Traps

The Department uses leg-hold traps both as a control method and as a monitoring method and kill-traps are used by control agencies and private individuals to control possums. New Zealand is a participant in an ISO Technical Committee (TC191) which aims to develop international standards for humane animal traps (Warburton 1995).

These international and national policies will restrict the use of most leg-hold and many kill traps. For example, trials on five kill traps suitable for possums showed only one (LDL 101) passed the tests for humaneness (Warburton 1995).

Biological control

Biological control is a common method used to control weeds and invertebrate pests. However, the use of other organisms to control vertebrate pests is very rare. One reason for this is that once the agent is liberated and established it is like Pandora's Box—we take the good with the bad in perpetuity. The introduction of mustelids and feral cats to control rabbits in New Zealand is a classic example: they give a large measure of rabbit control, but also adversely affect native animals.

Nevertheless, a successful biological control agent is probably the only way that we will ever control the entire population of widespread or ubiquitous pests such as possums.

New Zealand and Australia are investing substantial research sums on research on vertebrate biological control. Some recent advances include:

- Development of a sperm vaccine capable of preventing breeding in possums.
- Investigation of the technologies required to manufacture this vaccine using a genetically-engineered non-lethal virus, bacterium, or parasite specific to possums.
- Formation of a Co-operative Research Centre (CRC) for the Conservation and Management of Marsupials between Landcare Research, Macquarie University, Newcastle University, Perth Zoo, and the Queensland Department of Primary Industries. Common technologies on reproductive physiology are required to save endangered marsupials in Australia and manage pest marsupials in New Zealand.
- Several agencies in New Zealand and Australia are researching possums for diseases and parasites that might be used as biocontrol agents. To date in New Zealand three intestinal nematodes, a tapeworm, a fur mite, a bacterium causing "wobbly possum" disease, and of course bovine tuberculosis have been discovered. The possibility of introducing some disease or parasite found in Australian possums remains if one is discovered.

Maintenance control strategies

In the absence of a biological control agent for possums the only strategy the Department can use to protect conservation values from the pest is to reduce numbers (initial control) and then go back regularly and remove the natural increase in the population (maintenance control).

The frequency and intensity of this maintenance control needs to be determined primarily by the success of the initial operation and by the nature of possums' impacts on the resources at each place. Promoting public awareness of possum control and being proactive in creating a favourable social environment that accepts the need for aerial and ground control of possum operations must also be a primary consideration. The constraints on control technologies, e.g. cost, bait-shyness, accessibility, are also important considerations in determining the best frequency and intensity of maintenance control.

The first few years of the National Possum Control Plan have focused on initial control in new areas. Over time, however, most and finally all of the budget will be allocated to maintenance control regimes. It is estimated that at an average annual cost for maintenance control of approximately $8 /ha, and a total budget of $10.5 million (in 1995/96) the Department is able to control possums on a sustained basis on about 1,300,000 ha. Additional funding increases announced in the 1996 Budget may eventually allow sustained possum control to occur over about 1,700,000 ha. This is approximately the area in the top three risk categories listed in Table 1 and Figures 4 and 5. These maps are, however, based on NZFS forest type maps and current knowledge of general risk factors to the dominant species. There are gaps in the knowledge base and the areas considered at risk may increase as additional information becomes available. For example, there is recent information that possums are having significant impacts on biodiversity values (as opposed to biomass) of beech forests.

The Department has recognised that much of the past research on control technology has focused on improving initial control methods. In addition, the optimum frequency and location within operational areas of their application needs to be predicted or identified for each control operation.

Several research projects on maintenance control strategies have been begun recently funded by the Department (Table 3), and AHB. The largest of these aims to use the canopy assessment scores to measure the process of canopy tree recovery after an aerial control operation in an attempt to identify the point at which recovery stops and degradation recommences as possum numbers recover. The turnaround point will be used to determine when maintenance control is required.

The 1080 workshop

The Royal Society of New Zealand sponsored a major scientific workshop on 1080 in 1994. Twenty-one papers (eight from Australia, USA, or South Africa) were presented and published by the Royal Society. These results form the most complete modern database on the nature and use of 1080, set the scene for what is still required to ensure the safe use of the toxin, and underpin the publicity material produced on 1080.

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Appendix 1

Information, brochures, etc., on possum control produced since 1993 by the NPCA and its agencies

The NPCA and its agencies have produced and/or distributed a series of information brochures:

- *1080 some questions and answers* (published in 1994 and aimed at managers in control agencies, farming, and conservation groups dealing with public questions on the use of the toxin).
- Fa*ct sheet package* (produced by NPCA as 13 fact sheets on possum control aimed at farmers and others wishing to control possums).
- *The possum busters are coming* (1080 health and safety brochures produced by NPCA in consultation with the Ministry of Health and aimed at schools and pre-schools).
- *1080 is not kidstuff* (a MAF brochure aimed at primary schools).
- *Summary of possum management in New Zealand* (produced by the Parliamentary Commissioner for the Environment to summarise the key findings of her 1994 report).
- *Possum control and the use of 1080 in New Zealand* (produced by the AHB in 1994 and aimed at the public).
- *Possum control in native forests* (produced by DoC in 1994 and aimed at the general public).
- *1080 a review of the science* (produced by MoRST and aimed at scientists and managers).
- *Video on possum control* (produced by the NPCA for use in schools).

Appendix 2

Comparative photographs of possum damage and regrowth after control

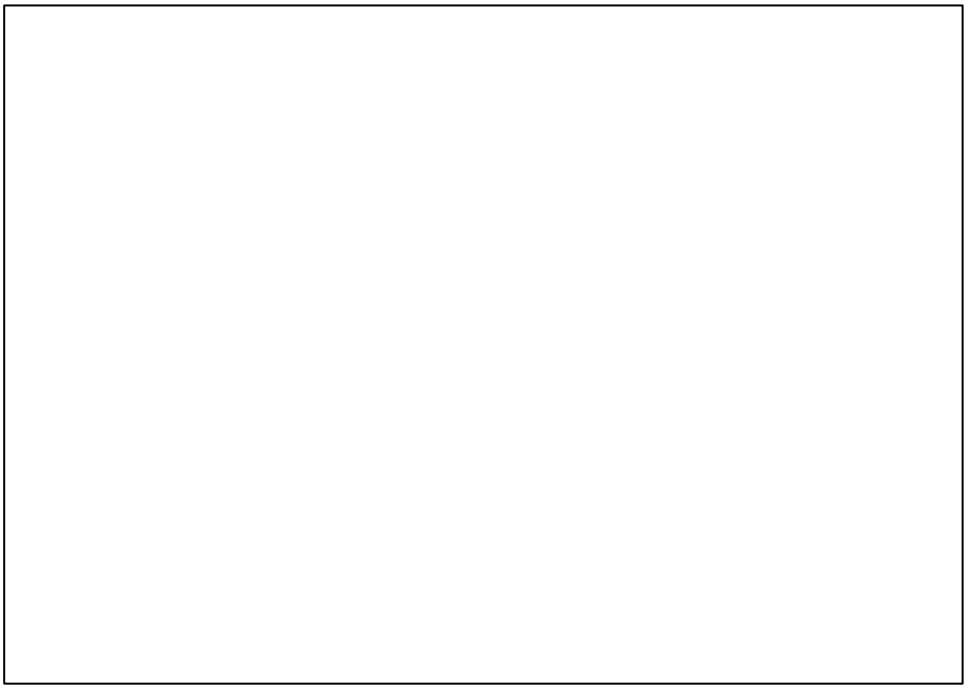

FIGURE 5. POSSUM BROWSE ON KOHEKOHE PRIOR. ONGOHI BUSH, WAIKATO CONSERVANCY. JULY 1991.

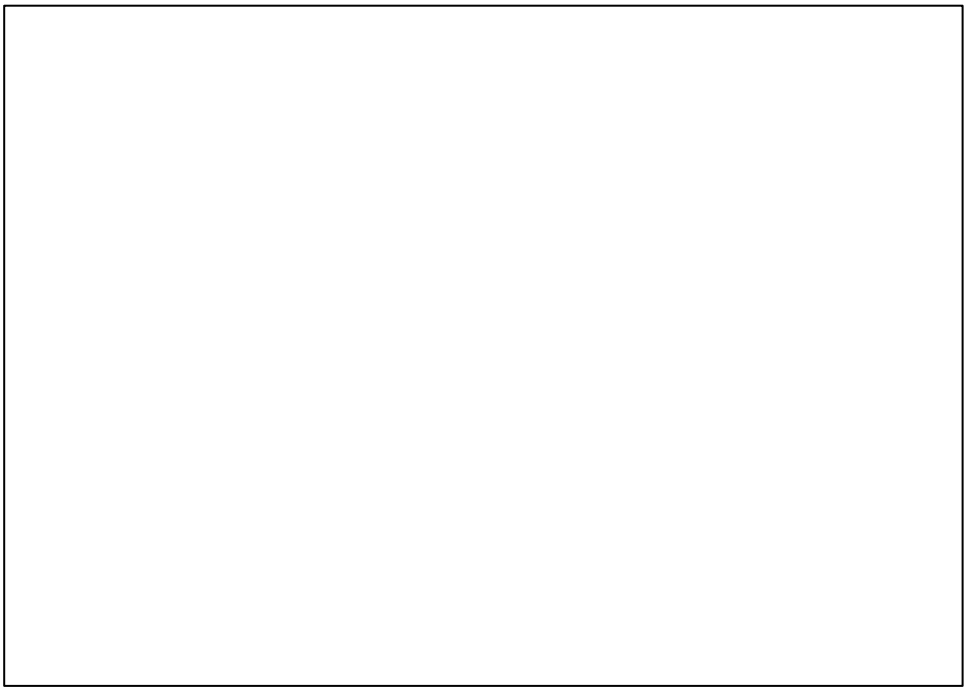

FIGURE 6. KOHEKOHE TREE AFTER POSSUM CONTROL. ONGOHI BUSH, WAIKATO CONSERVANCY. APRIL 1992. NOTE THE CONSIDERABLE AMOUNT OF NEW FOLIAGE.

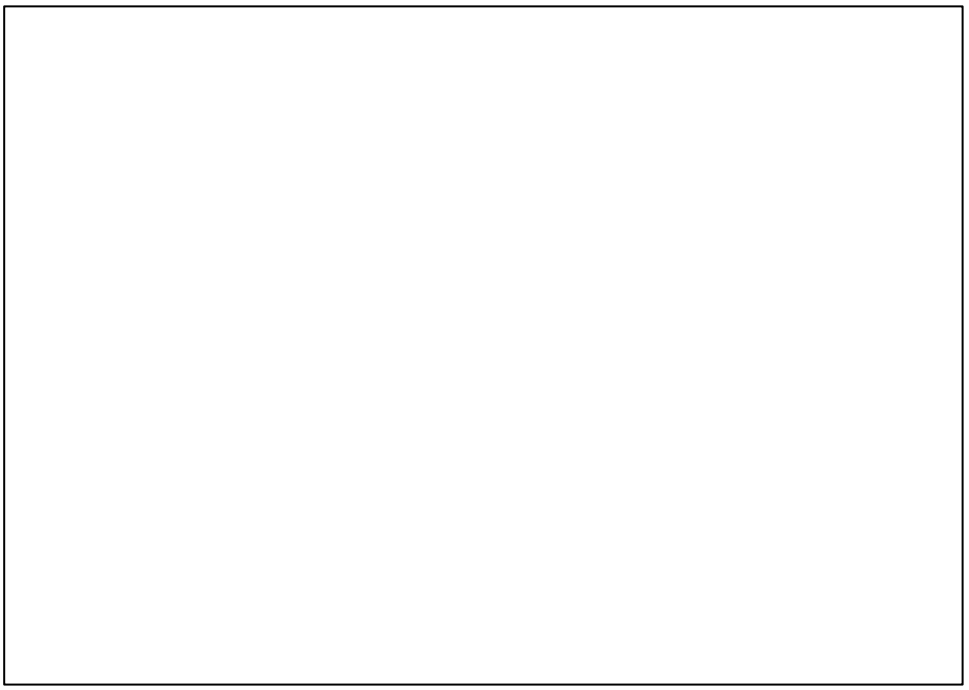

FIGURE 7. KARIOI MILLWARDS CANOPY DENSITY LINE #1 PRIOR TO POSSUM CONTROL. NOVEMBER 1993. WAIKATO CONSERVANCY.

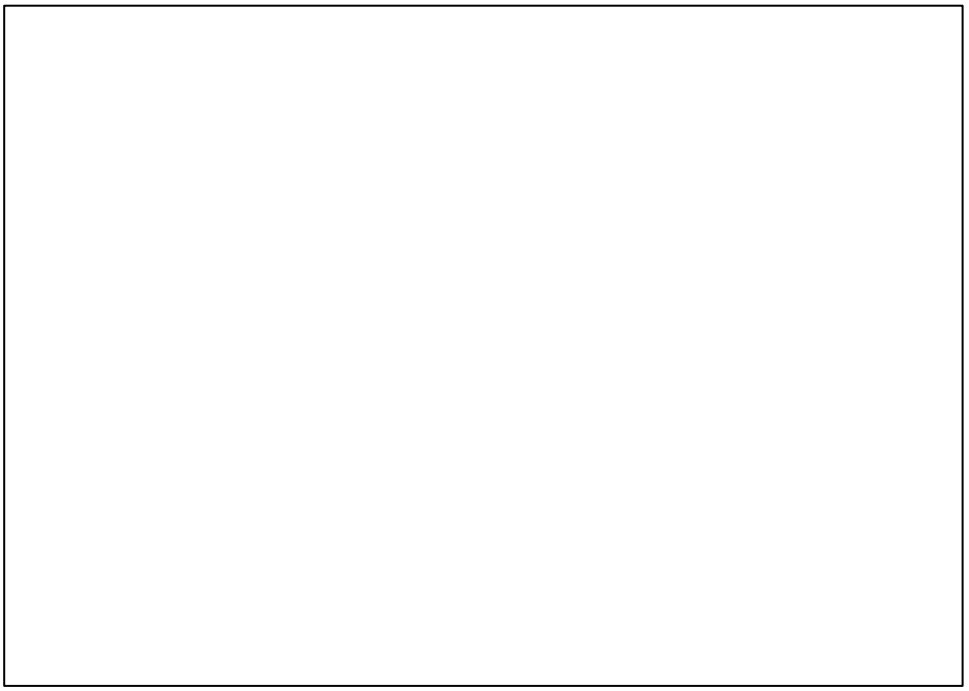

FIGURE 8. KARIOI MILLWARDS CANOPY DENSITY LINE #1 AFTER POSSUM CONTROL. NOVEMBER 1995. WAIKATO CONSERVANCY.

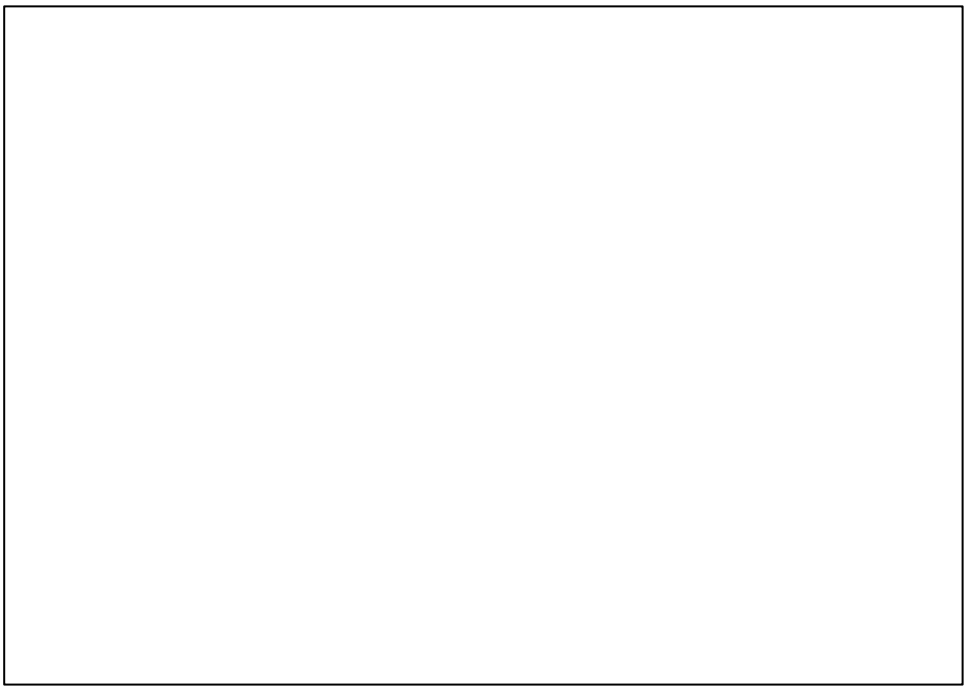

FIGURE 9. MONITORED TREE #5 IN WAIHAHA FOREST PRIOR TO POSSUM CONTROL. AUGUST 1994.

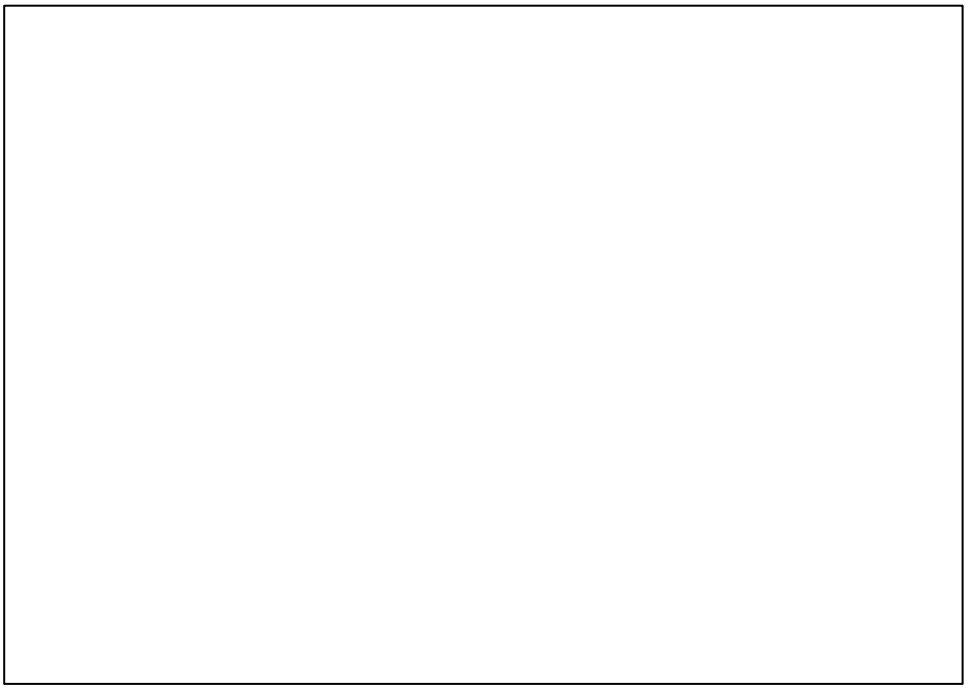

FIGURE 10. MONITORED TREE #5 IN WAIHAHA FOREST AFTER POSSUM CONTROL. APRIL 1995. NOTE THE SIGNIFICANT INCREASE IN CANOPY DENSITY.

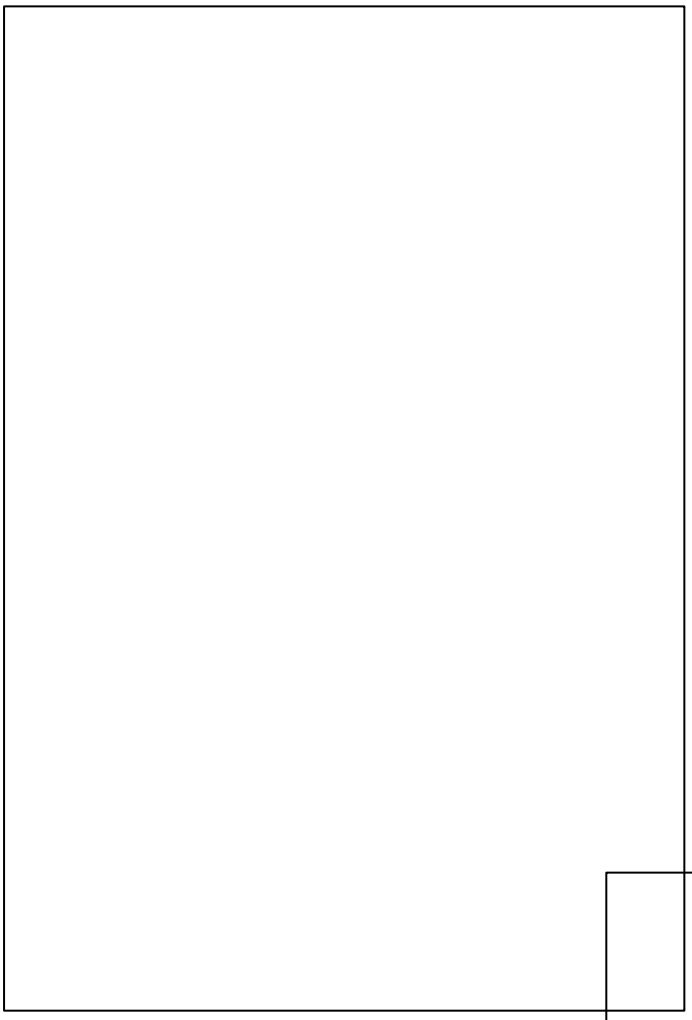

FIGURE 11. POSSUM BROWSED TOTARA TREE IN WAIHAHA FOREST PRIOR TO POSSUM CONTROL. JANUARY 1994. WAIKATO CONSERVANCY.

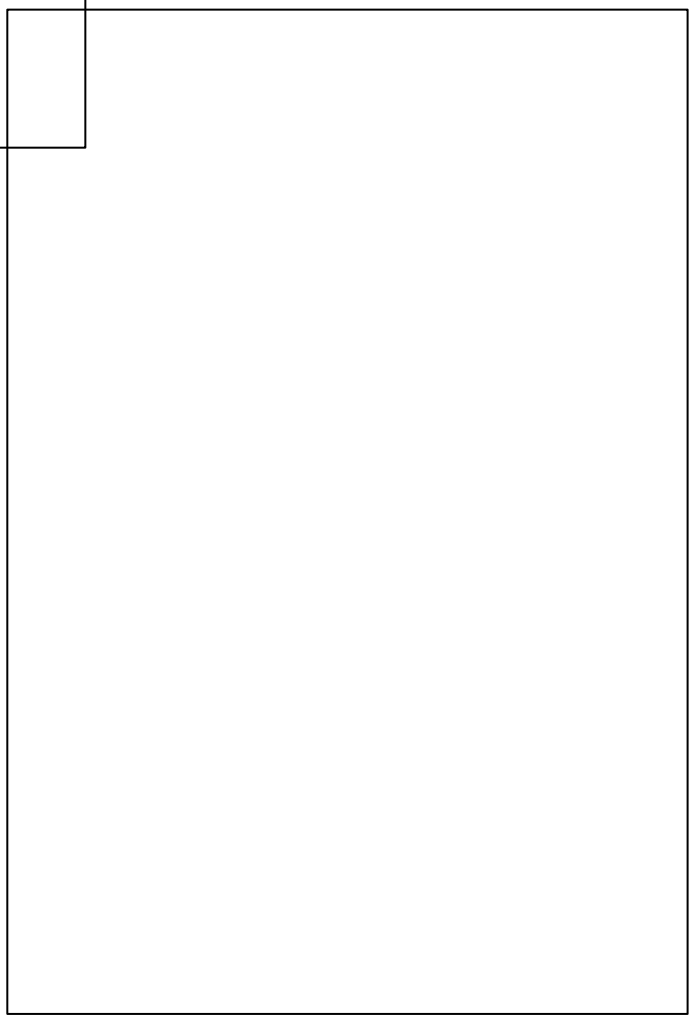

FIGURE 12. A SIMILAR TOTARA TREE IN WAIHAHA FOREST SUBSEQUENT TO POSSUM CONTROL. MARCH 1995. WAIKATO CONSERVANCY.