Impacts of possum browsing on the long-term maintenance of forest biodiversity

SCIENCE FOR CONSERVATION: 103

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Published by
Department of Conservation
P.O. Box 10-420
Wellington, New Zealand

Science for Conservation presents the results of investigations by DoC staff, and by contracted science providers outside the Department of Conservation. Publications in this series are internally and externally peer reviewed.

ISSN 1173-2946
ISBN 0-478-21786-2

This publication originated from work done under Department of Conservation Investigation no. 1982, carried out by P.J. Bellingham, S.K. Wiser, G.M.J. Hall, Rob B. Allen and P.A. Suisted, Landcare Research, P.O. Box 69, Lincoln; and J.C. Alley, Private Bag 11052, Palmerston North. It was approved for publication by the Director, Science & Research Unit, Science Technology and Information Services, Department of Conservation, Wellington.

Cataloguing in Publication
Impacts of possum browsing on the long-term maintenance of forestbiodiversity / P.J. Bellingham ... {et al.}. Wellington, N.Z. : Dept. ofConservation, 1998.
1 v. ; 30 cm. (Science for conservation, 1173-2946 ; 103.)
Includes bibliographical references.
ISBN 0478217862
1. Forest health—New Zealand. 2. Forest conservation—NewZealand. 3. Forest ecology—New Zealand. 4. Trichosurus vulpecula—Environmental aspects—New Zealand. I. Bellingham, P. J. II. Series: Science for conservation (Wellington, N.Z.) ; 103.
581.52230993 20
zbn98-117756

CONTENTS

Abstract

Although brushtail possums (*Trichosurus vulpecula*) are known to browse many major trees in New Zealand's conifer/broad-leaved forests, little is known of their long-term effects. We examined long-term (14–25 years) changes in five conifer/broad-leaved rainforests, which have had various histories of possum occupancy and control, and various degrees of mortality of canopy tree species. All five contain species known to be browsed by possums, such as Hall's totara (*Podocarpus hallii*), kamahi (*Weinmannia racemosa*), and southern rata (*Metrosideros umbellata*). Although extensive dieback of canopy species had occurred in some forests before censuses began, most showed no substantial changes in species composition during the census period. In one area (Kokatahi), there was major mortality of canopy species over a small part of the catchment. In all study areas the changes observed reflect sampling effort in time and space. We show that dieback events of canopy trees are not simultaneous, and progress in patches in catchments, often over many decades. Hall's totara declined over a similar time in three Westland areas which had different histories of possum populations and control. Other species palatable to possums, especially kamahi, remained relatively unchanged. In the study areas, stem density tended to increase, while biomass remained largely unchanged; we interpret this to mean that the large increase in shorter trees, such as horopito (*Pseudowintera colorata*), was sufficient to offset the death of taller canopy trees, such as Hall's totara. In these catchments, standing dead stems can contribute to total mass of woody material for many decades after the death of trees. Regeneration of former canopy tree species, e.g. kamahi, occurred in some post-dieback forests but not in others. We conclude that possum control in these catchments, which has been infrequent and at a broad scale, has had little apparent effect in arresting the declines of some palatable tree species. We propose that better understanding of life histories of vulnerable tree species should identify better approaches to possum control in future.

1. Introduction

The long-term impacts of possum browse were studied in five New Zealand conifer/broad-leaved rainforests, in which canopy trees frequently browsed by possums are common. The study examined changes in forest structure, composition and biomass, using data collected between 1969–1996, and included some forests where widespread mortality was or had been present. The study was carried out by Landcare Research for the Department of Conservation Science and Research Division.

2. Background

Rainforests comprising a mixture of conifers and broad-leaved species (other than beech (*Nothofagus* species) are a major part of New Zealand's indigenous forest cover. In a review of the composition and dynamics of these forests, Wardle et al. (1983) declared 'the death of dominant trees has caused much concern during the last thirty years. In many instances, this has followed the establishment of brush-tailed possums, which browse and undoubtedly weaken trees, although the final demise may result from a combination of adverse events.' Long-term trends in these forests and the impacts of introduced browsing mammals, especially brushtail possums (*Trichosurus vulpecula*) are still a concern more than a decade later (e.g. Rogers and Leathwick 1997). Several recent aerial surveys of large areas of these forests in montane areas of the southern North Island (Rogers and Leathwick 1997) and central Westland (Rose et al. 1992) have drawn attention to ongoing widespread mortality (dieback) of canopy trees.

Earlier research (e.g. Chavasse 1955) emphasised the combined role of possums and ungulates as possible contributors to the phenomenon of widespread mortality of canopy trees. Wardle et al. (1983) commented that 'in some localities death of the canopy combined with modification of the understorey and destruction of seedlings by deer have proved disastrous.' In many of the areas where conifer-broadleaved rainforests dominate, populations of ungulates peaked between the 1940s and 1960s; subsequently populations declined and have been maintained at low levels by commercial hunting pressure (McKelvey 1995). In contrast, possums have continued to expand in range (Cowan 1990) and populations are likely to remain at high levels. Consequently our study focussed on areas where possum numbers remain high, and ungulate numbers are now low, although the latter may have had considerable impact on the vegetation, especially in the understorey, in the past. While introduced mammalian herbivores contribute to the death of trees in these forests (Wardle et al. 1983), other factors are known to be major influences, and include insect damage (Hoy 1958, Payton 1989), fungal damage (Payton 1989), water stress, either excess or deficit (Jane and Green 1983, 1986; Grant 1984), wind (Cunningham 1979), and population age structure of trees (Veblen and Stewart 1982).

To date, most research in these forests has relied on an assessment of forest change at one point in time, combined with an appraisal of historic data for sites (e.g. Stewart and Veblen 1982, Rose et al. 1992, Rogers and Leathwick 1997). Therefore, little is known of long-term changes and dynamics of these forests, and their geographic variation. Because dead trees (e.g. southern rata) remain standing for long periods, the only appropriate way to study variation in mortality rates is to follow the fate of marked individuals. Further, we know little about how these ecosystems change after death of adult trees, and the nature of the communities that develop subsequently. Aerial poisoning of possums has taken place in most of the catchments in which forest dieback has occurred, but little is known about whether these operations have been effective in protecting populations of tree species known to be palatable to possums. The decline of some palatable tree species may have implications for the biomass of these forests. The role of New Zealand's indigenous forests in carbon storage is controversial (Hall and Hollinger 1997), and it is therefore appropriate to examine in more detail changes in biomass within forests where widespread mortality either has occurred or is occurring.

3. Objectives

- To examine long-term trends in rainforest structure and composition, where possum control has been intermittent, and where current numbers are likely to be high.
- To examine conifer/broad-leaved forests (Wardle 1991), characterised by an absence of beech species, in a range of mostly montane study areas from the southern North Island to the central South Island, using permanent plots established mostly in the 1970s, and from which we have from 14 to 25 years of census data on forest structure and composition.

Using data from these long-term records we ask:

- Can we generalise the pattern of dieback and recovery among areas?
- Does dieback of forests modify composition; if so, how is it influenced by temporal and spatial scale?
- Do forests that develop after canopy dieback differ in their stand basal area and biomass from communities where dieback has not occurred?
- What implications do dieback events have for the amount of carbon stored in the study areas?
- What tree species regenerate in these communities and to what extent do the seedling and sapling floras resemble either present or former forest canopy composition?
- Can we detect whether past aerial poisoning operations against possums have been effective in arresting the decline of palatable canopy species?

Because the correct interpretation of our data for these questions requires an understanding of the dynamics of common canopy trees known to be browsed by possums, we consider their life histories, including the particular microsites where these species regenerate (cf. Grubb 1977).

4. Methods

4.1 STUDY AREAS AND DESIGN

To compare changes over time in composition and biomass of conifer/broad-leaved forests, we chose five study areas from which long-term data were available. The study areas are located along the main axial ranges of the North and South Islands, between 40°S and 44°S latitude (Fig. 1, Table 1). Among the five study areas canopy condition varied. In three study areas (Orongorongo, Taramakau, and Copland), forest canopies were largely intact when plots were established. In Taramakau and Copland, plots were established in areas where crowns of some canopy trees (especially southern rata, *Metrosideros umbellata*) appeared to be deteriorating. In Kokatahi, plots were established both where forest canopies were intact and where widespread death of canopy trees, especially southern rata and kamahi (*Weinmannia racemosa*), had occurred at least 20 years earlier. In Pohangina, all plots were established in forests mostly composed of short-stature trees and tree ferns that had developed after the death of canopies previously dominated by northern rata (*Metrosideros robusta*) and kamahi (Elder 1965, Cunningham 1979). Other than podocarps, little remains of the former canopy (Fig. 2). Beeches

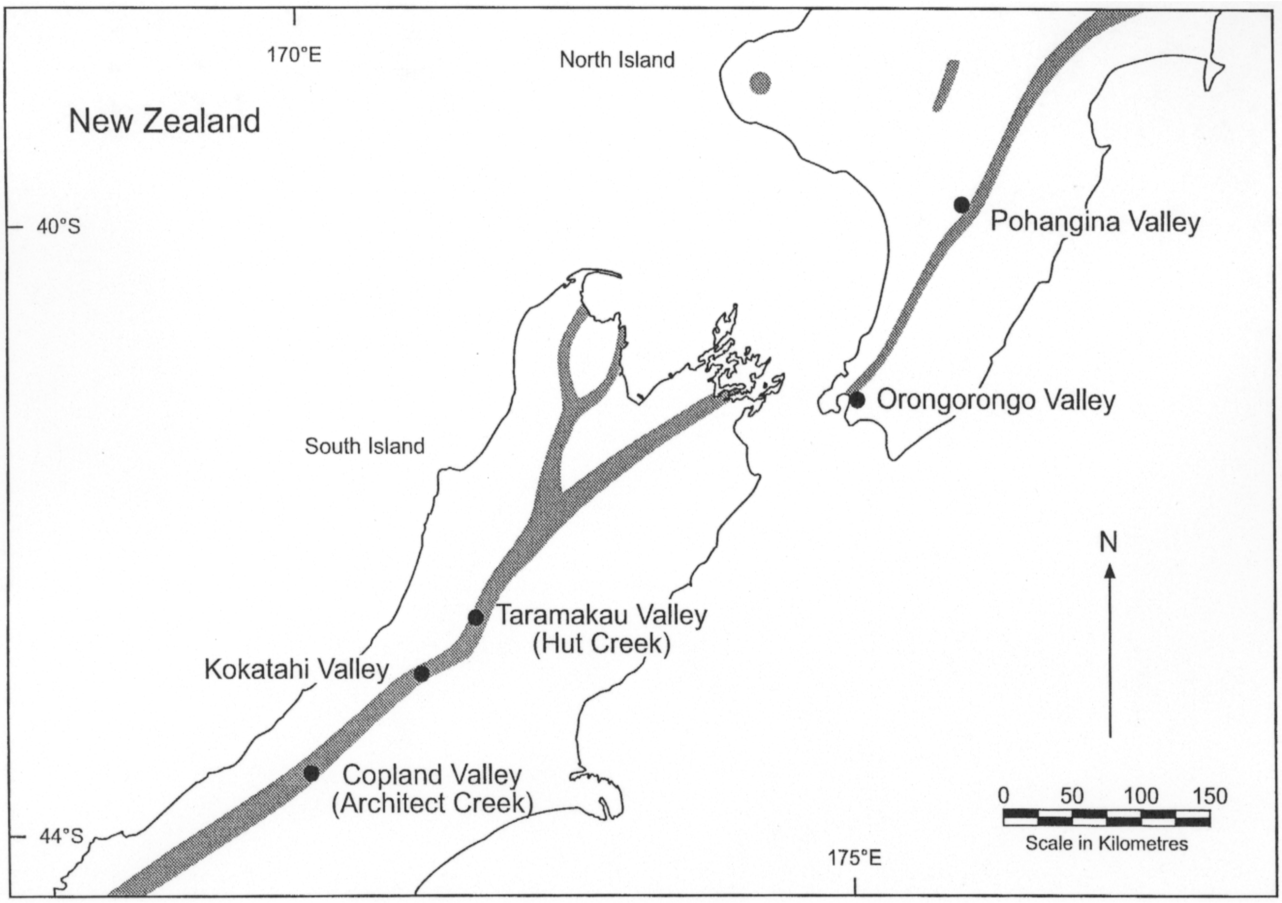

Figure 1. Map of central New Zealand, showing the locations of the five study areas. The main dividing ranges of the North and South Islands are also shown.

Figure 2. Podocarp trees, miro (*Prumnopitys ferruginea*) and rimu (*Dacrydium cupressinum*), emergent over a canopy dominated by *Cyathea smithii* and mahoe (*Melicytus ramiflorus*). Note the gap between the lower branches of the podocarps and the existing canopy. This is because they were emergent over a former tall canopy dominated by kamahi (*Weinmannia racemosa*) that died during the 1950s–1960s. Centre Creek, Pohangina Valley, Ruahine Ranges, March 1996.

(*Nothofagus* spp.) are absent from all areas except Orongorongo, where they are a very rare component in the study plot, although they are widespread in the catchment (Brockie 1992).

The five study areas were chosen to reflect a range of invasion histories, different times of possum population peaks, and different histories of control (Table 2). Therefore we could determine whether changes in forests were related to past possum population levels, and how effective past control operations may have been in preventing declines in species palatable to possums. There have been no recent estimates of possum numbers in Pohangina (K. Mills, pers. comm.) or in any of the three central Westland study areas (T. Farrell, pers. comm.). In Orongorongo, numbers of possums have fluctuated about a mean of 8 per ha from the 1960s to 1994 (Brockie 1992, Cowen et al. 1997).

Feral ungulates are present in all of the study areas. In Copland, red deer (*Cervus elaphus*) colonised the valleys during the late 1940s–early 1950s, peaked during the early 1960s, and decreased thereafter (Pekelharing and Reynolds 1983). Red deer were liberated near all the other study areas late last century or early this century; numbers peaked during the 1950s, and have declined to low numbers through a combination of natural reduction in populations and sustained hunting pressure (e.g. Cunningham 1979, Brockie 1992, McKelvey 1995). In Pohangina, Orongorongo, and Kokatahi, the peak of red deer populations coincided with peaks in possum populations (Table 2). Feral goats (*Capra hircus*) are present in all study areas, but estimates of populations over time are known only from Orongorongo, where they were present in large numbers early this century. Their numbers have been reduced by culling since the 1950s, and by the end of the 1970s numbers were low (Brockie 1992). In addition to red deer and goats, chamois (*Rupicapra rupicapra*) are present in the three Westland study areas. Chamois were liberated in 1907 and 1914 in the Hooker Valley of Mount Cook National Park (Clarke 1990). In the Copland valley their populations were moderate in the 1950s, peaked during the 1960s, and subsequently declined (Pekelharing &

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