Impacts of deer on Kaimanawa beech forests

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Contribution of others to study

While this PhD thesis is substantially my own work there has been considerable input from others, particularly assistance with fieldwork and reviewing of manuscripts. Several hundred permanent plots have been repeatedly measured for this study. Typically, each plot took a team of four people a full day to establish or re-measure. After data collection took place there was an equally large amount of effort required to enter data into databases, and then to check and correct errors. The sampling design for fenced and unfenced plots used in chapter five was devised by Chris Ward (East Coast/Hawkes Bay Conservancy), and sites were selected and plots established by Department of Conservation staff from Tongariro/Taupo and the East Coast/Hawkes Bay Conservancies.

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Abstract

Extensive mountain beech (*Nothofagus solandri* var. *cliffortioides*) canopy collapse has been apparent for decades in the Kaimanawa Region, central North Island of New Zealand. In most other unlogged mountain beech forests prolific seedling regeneration follows canopy collapse, but in the central North Island regeneration has been impeded by red (*Cervus elaphus*) and sika deer (*Cervus nippon*) browsing. The primary objective of this study was to determine relative impacts on mountain beech regeneration of red and sika deer, and the impacts of deer in general on Kaimanawa Region beech forest composition. Previous international research has shown that herbivores can drastically modify seedling species composition, but the ongoing consequences of herbivory for canopy composition and competitive interactions between plants on a landscape-scale are still poorly understood. This PhD uses short and long-term monitoring of vegetation to examine the effects of herbivory on forest regeneration and successional processes. In an attempt to restore mountain beech regeneration, high intensity deer culling was initiated in October 1998 to reduce deer densities. A further objective of this study was to determine the effect of deer culling on deer densities and mountain beech seedling growth.

Data from 20 m x 20 m permanent plots are used to relate the impacts of sika and red deer to changes in mountain, red (*Nothofagus fusca*) and silver (*Nothofagus menziesii*) beech forest composition and regeneration. Plots were established on randomly located transects over two decades ago and were re-measured periodically since. Mountain beech seedling abundance is compared among areas with different sika deer colonisation histories to determine impacts of sika deer over time. Comparisons are also made with areas outside the region, where no sika deer were present.

At ten subjectively located sites, paired fenced and unfenced plots were established in a high-intensity deer culling area between 1997 and 1999, to monitor benefits of deer culling for mountain beech seedling growth. To provide comparisons, paired plots were also established at eleven sites in areas with low- and medium-intensity deer culling.

Results show that sika deer have widespread impacts on Kaimanawa beech (*Nothogagus* spp.) forest regeneration and composition. Where sika deer have been dominant over red deer for more than a decade, mountain beech seedling regeneration has been suppressed in comparison to areas without sika deer. This is particularly evident at stands which had low
occupancy by trees, and where prolific seedling regeneration is expected due to increased nutrient and light availability.

Mountain beech forest composition in the Kaimanawa Region has undergone shifts towards browse-tolerant and browse-resistant species over the last two decades. In red and silver beech forests there was an increase in the stem densities of species of small trees that are unpalatable to deer. Analysis of seedling densities indicates that deer-palatable *Weinmannia racemosa* and *Griselinia littoralis* trees were failing to recruit into the >75 cm height class. In the southern part of the Kaimanawa study area understorey composition shifted over two decades towards browse-tolerant turf forming herb, fern, grass and bryophyte communities, which may have been due to the presence of deer.

Analysis of seedling growth rates from paired fenced and unfenced plots provides strong evidence that mountain beech seedling growth increased once deer browsing was removed through fencing, and to a lesser extent following reductions in deer abundance through high-intensity deer culling.

I established two experiments to examine the relationships between herbivory and competition between mountain beech seedlings and other turf-forming plant species. These experiments showed that the composition of turf communities had little effect on mountain beech seedling establishment, but their complete removal increased mountain beech seedling growth and survivorship. There was no immediate compositional response of turf communities to the removal of deer browsing, so the reversibility of deer-induced impacts are unclear.