EFFECTS OF FIRE ON TALL-TUSSOCK (*Chionochloa rigida*) GRASSLANDS IN OTAGO

Annual update on a joint research project being carried out by Landcare Research, Forest Research, AgResearch, and the Department of Conservation — 2002/03

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Background and rationale

There are several, often highly emotive issues surrounding the deliberate use of fire in high country tussock grasslands.

(i) Runholders wish to retain an ability to burn tussock grassland to promote palatable regrowth, improve stock access, and reduce or remove what are seen as "woody weeds". The issues here are the extent to which these practices degrade the physical (e.g., soil fertility) and biological (e.g., native plant and animal life) resources within the grasslands.

(ii) The retirement of large areas of tussock grassland from pastoral use raises the issue of whether the increased biomass (fuel load) of tussock grasslands that are no longer burned or grazed by stock poses an increased fire risk.

(iii) From a conservation perspective there is also the issue of whether deliberate burning under damp spring conditions (the current pastoral management practice) is less damaging to the native biota than an accidental fire when weather conditions are hot and dry.

Fire is currently little used for conservation management in New Zealand. In order to assess the potential risks and possible benefits of using fire as a management tool in high country tussock grasslands we need to know (i) how rapidly and to what level biomass increases in tussock and tussock/shrubland communities retired from fire and grazing, and (ii) how fire affects vulnerable plant and animal species, and the ways in which any lasting impacts can be minimised.

Despite a long history of fire research in New Zealand most studies have concentrated soley on changes to the dominant tall-tussock (*Chionochloa*) species, and none have included both pre-fire assessment of the physical and biological resources, and characterised the nature of the fire.

Project proposal

The original intention of the study, based on the 1992 debate surrounding the burning of red tussock grassland in central Otago, was to compare the effects of fire on red (*C. rubra*) and snow (*C. rigida*) tussock grasslands. In April 1997 a meeting of interested parties from conservation (Department of Conservation, Royal Forest & Bird Protection Society), farming (Federated Farmers), regional government (Otago Regional Council) university (Botany Department, Otago University) and government research agencies (Landcare Research, Forest Research) amended this to a comparison of snow tussock communities from coastal (maritime) and inland (subcontinental) environments in Otago.

The study aims to provide information on the following questions

(i) Does fire cause long-term damage to native plant and animal populations and the fertility of snow tussock grasslands ?

(ii) Are accidental summer fires more damaging than prescribed burns in late winter or early spring ?

(iii) Can we predict fire behaviour based on the amount of available fuel (plant biomass) and the local weather conditions ?

The experimental sites are at Deep Stream near Dunedin (coastal range site), and at Mt Benger near Roxburgh (inland range site). The former is on land managed by the Dunedin City Council and the latter is part of a pastoral leasehold block. Each of the experimental sites has 9 x 1ha plots (the minimum size needed to determine the fire characteristics), and is equipped (courtesy of the National Rural Fire Authority) with an automated fire weather station. Three of the plots remain unburned, three are burned under spring conditions, and the remaining three in summer or autumn.

The project is a collaborative venture between Landcare Research, Forest Research, AgResearch, and the Department of Conservation, with funding from the Foundation for Research, Science and Technology, the Department of Conservation and the Hellaby Indigenous Grasslands Research Trust.

Landcare Research and AgResearch staff are determining changes to the vegetation composition, plant biomass and nutrient pools. The quantities of plant material and nutrients in the grassland are measured using quadrat harvests and soil cores. The plant material is sorted by species or species group and subsamples are analysed for their nutrient content.

AgResearch staff are also measuring changes to invertebrates. They are using turf samples and soil cores to quantify the numbers of litter and soil dwelling groups of invertebrates. The former are extracted using Berlese funnels, and the soil cores are hand sorted to provide estimates of earthworm numbers and the soil dwelling stages of insects such as cicadas and scarab beetles.

Forest Research fire researchers determine fire behaviour, in particular the rate of fire spread and fuel consumption. This provides a measure of the intensity of the fire and, in conjunction with measurements of fuel moisture and fire temperature, enables the severity of each burn to be described. Temperature profiles and maximum temperatures reached during each fire are determined using electronic temperature sensors and metal plates coated with heat-sensitive paints, which are placed in the soil and at varying heights above the ground. The data will also be used to help develop predictive models of fire behaviour based on parameters such as slope, fuel availability and weather conditions. The models are a necessary first step for developing safe and effective strategies for fighting tussock wildfires, and for defining appropriate conditions for prescribed burning or the imposition of fire restrictions.

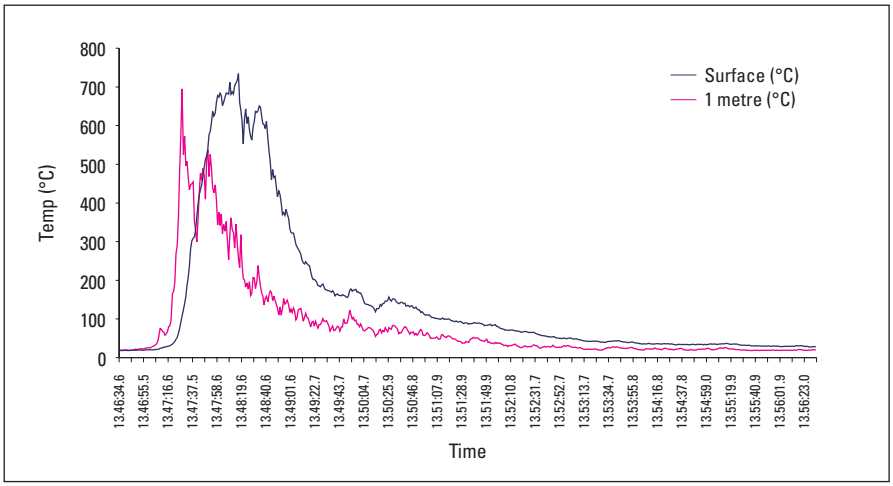
Fire safety at the experimental burns is the responsibility of Department of Conservation firefighters, supported by local rural fire crews.

Progress report

We're a bit late with this year's update. My apologies for that. The upside of the delay is that the invertebrate researchers (Colin Fergusson and Barbara Barratt) from Invermay have been able to progress their analyses to a point where they can show you how the fires have affected a range of invertebrate groups. Since the last update we have completed the spring burns at Deep Stream. Despite being burned a month earlier than the corresponding plots at Mt Benger (where the grasslands are recovering well) the spring fires at Deep Stream did considerable damage to the tall-tussocks, as those of you who attended the Mountainlands Conference field trip in February will have seen.

Previous progress reports have focussed on the changes in plant biomass and nutrient pools resulting from fire. In this report we've shifted the focus to the invertebrate component of the project. But first we thought you might be interested to see a temperature profile from one of the spring burns at Deep Stream, courtesy of the Forest Research fire research team from Ilam.

For those of you who know the layout of the Deep Stream plots, this temperature profile was generated from Plot 3, the spring-burn plot nearest the climate station. It was obtained by placing temperature sensors at ground level and at one metre above-ground near the centre of the plot. These were connected to a datalogger and laptop computer, which were buried to protect them from the fire. Temperatures at both heights reached about 700°C. They peaked first above-ground, but remained elevated for longer at ground level. Within 6-10 minutes of peaking, both temperatures had returned to near ambient levels.

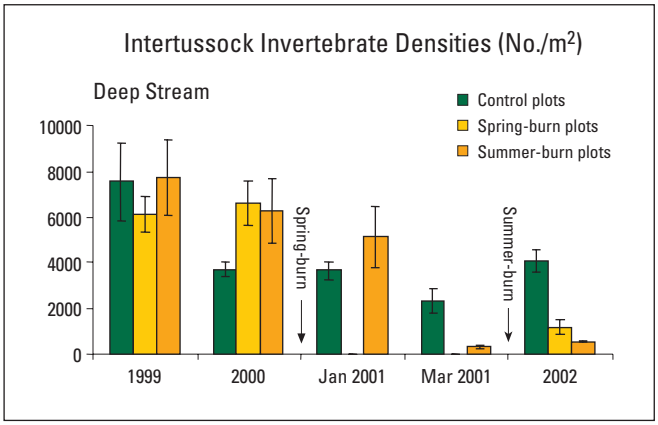


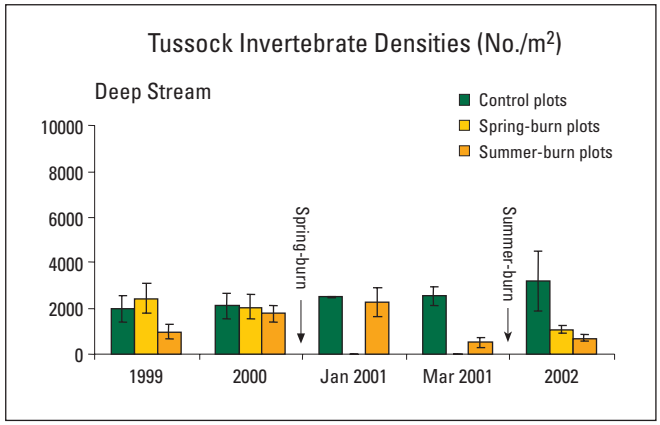
Invertebrates

Invertebrates contribute a large proportion of the species diversity in tussock grasslands (and in other ecosystems), and are an important part of the processes that recycle nutrients. The surface dwelling invertebrates at Deep Stream and Mt Benger have been sampled each spring and summer since August 1998. This is done by cutting 0.1-m^2 turfs from within and between the tussocks. The invertebrates are removed from these samples using heat-extraction funnels, and are sorted and counted into broad taxonomic groups. Currently the data provide a quantitative estimate of invertebrate abundance and diversity at the order or family level for insects, and at higher taxonomic levels for other invertebrate groups. Logistically this is a massive undertaking (over 500,000 specimens identified to date) but a necessary one if the rresults are to be reported in a quantitative manner, something that is not often attempted.

Deep Stream plots

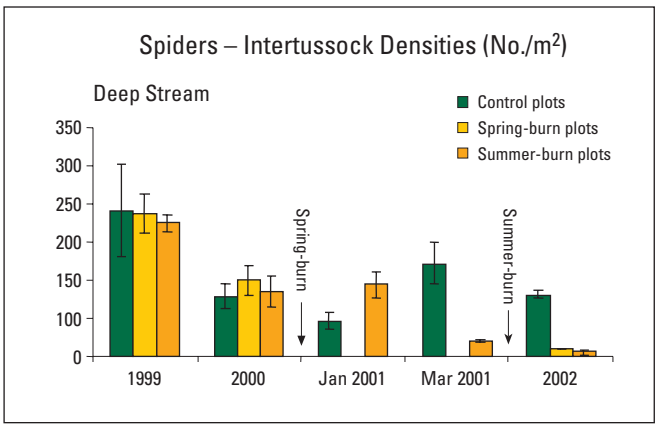
On unburned plots invertebrate densities range from 2345 to 7748/m^2 in areas between tussocks, and from 936 to 3224/m^2 within the tussock crowns, and there is considerable variation between years. Most plots have higher densities of invertebrates in the intertussock areas. Invertebrate densities declined significantly after both the spring (October 2001) and summer (March 2001) burns, more so in the intertussock areas.

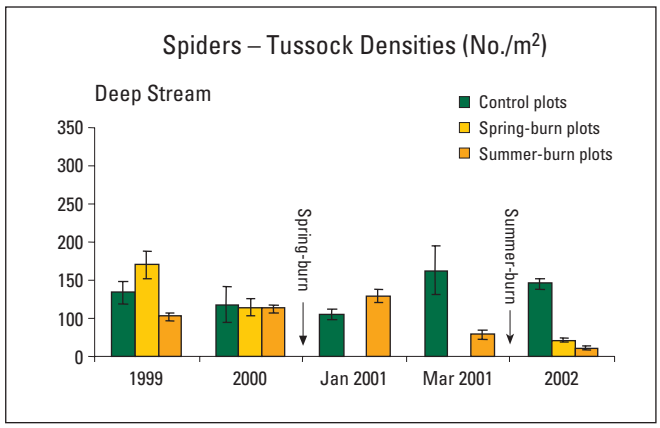




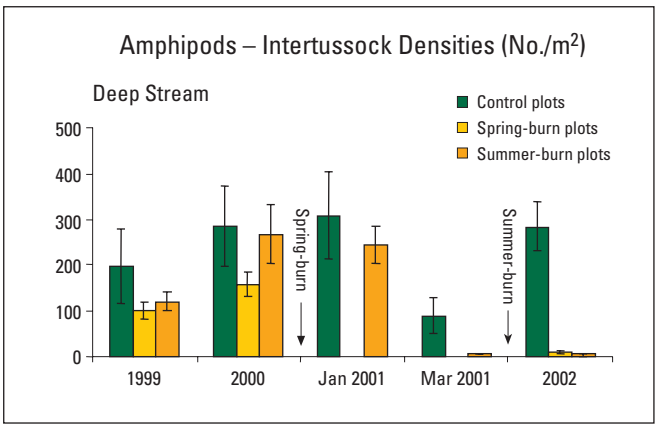
Some examples of invertebrate group response to the fires at Deep Stream:

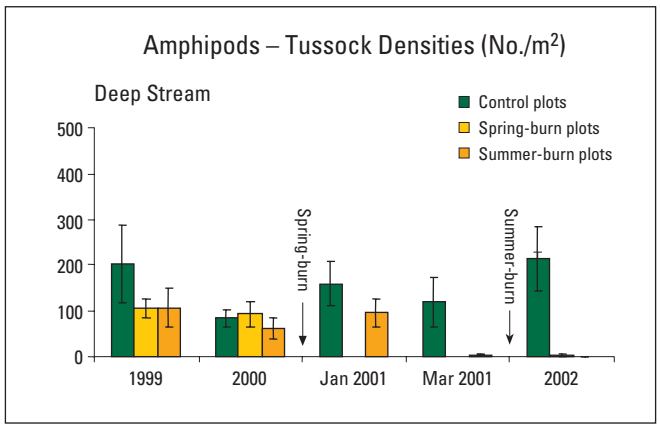
Spiders are a relatively abundant predator group in the Deep Stream grasslands and before the burns were generally evenly distributed over all the plots. Marked variation in density was apparent between years. Both the spring (October 2001) and summer (March 2001) fires reduced spider densities and these remained lower 3 and 10 months after the fires, respectively, than in the control plots. At this stage there is no indication that numbers are returning to pre-burn or control plot levels.



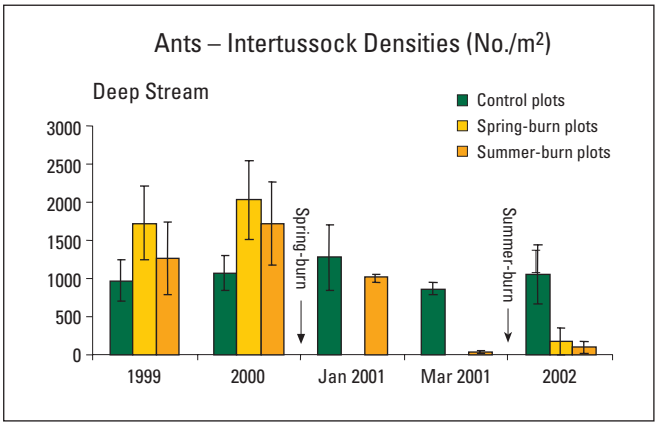


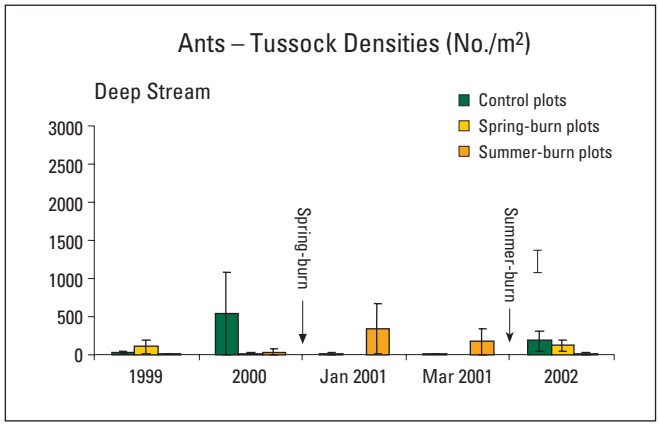
Amphipods or bush hoppers are another common invertebrate group. Both spring and summer burns reduced amphipod numbers. At this stage there is no indication that these are recovering to pre-burn levels.



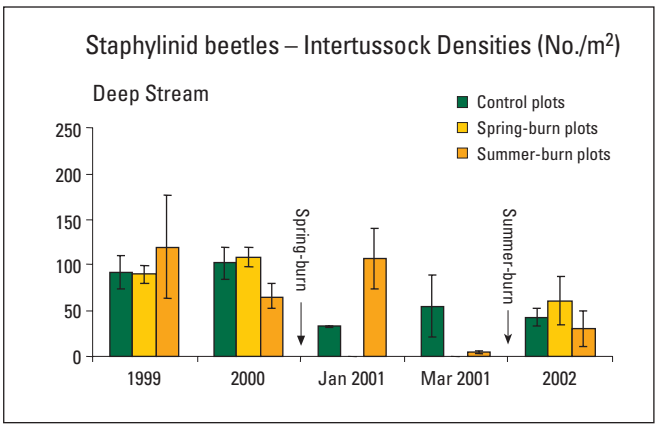


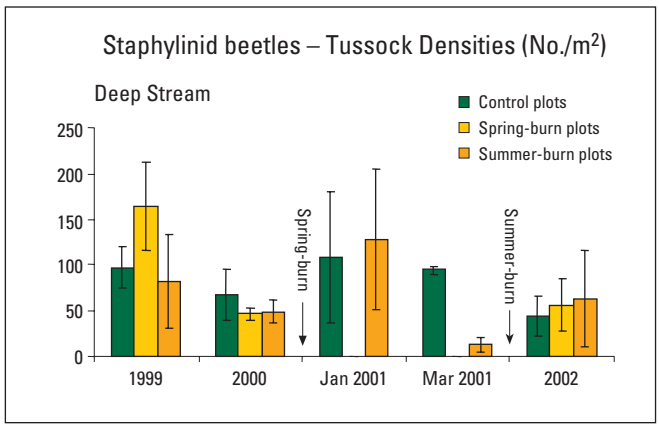
Ants are a very numerous group, with highly aggregated distributions. Low numbers are often obtained from individual sample units, but it is also common to collect whole nests containing several hundred individuals. Although numbers were much reduced by both spring and summer fires, ants remain common on burned plots.



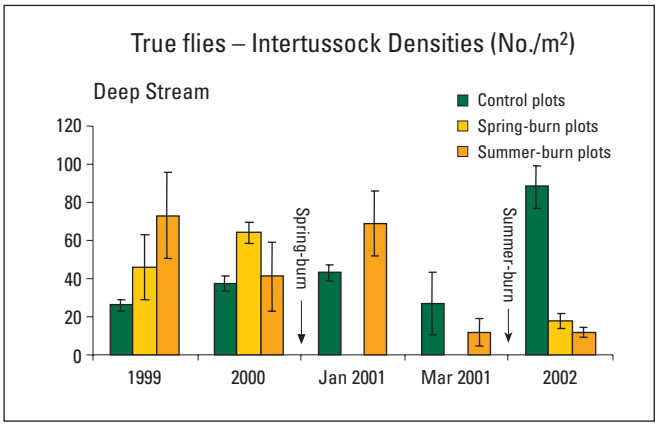


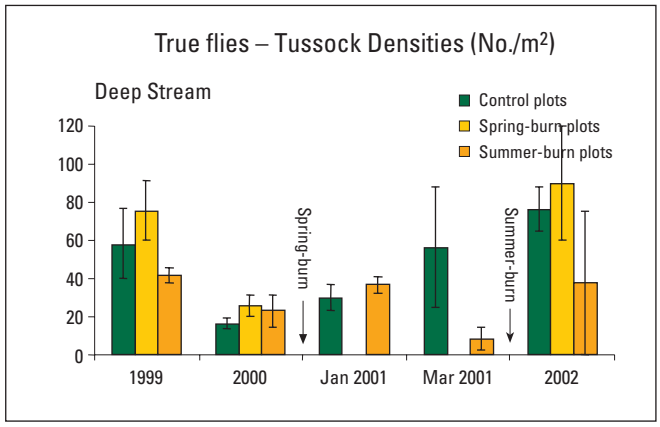
The most common family of beetles in the Deep Stream grasslands is the **Staphylinidae**. For this group of beetles reductions in density associated with the fires were apparent immediately after the burns, but by January 2002 the numbers in the summer- and spring-burn plots were similar to the control plot and pre-burn levels.





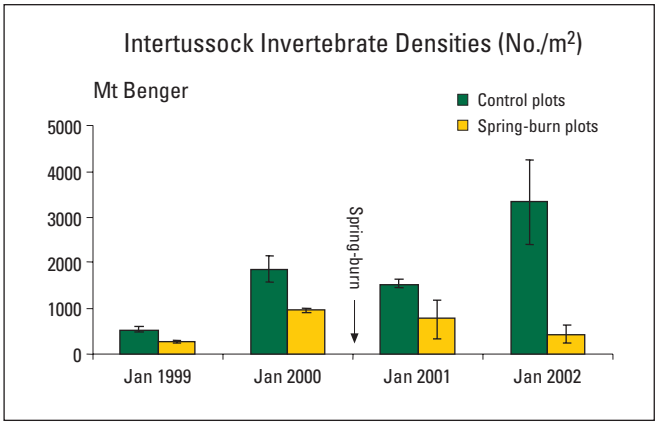
Diptera or true flies. The burns had immediate negative effects on numbers of dipteran larvae, but by January 2002 these appeared to be returning to pre-burn levels especially in tussocks.

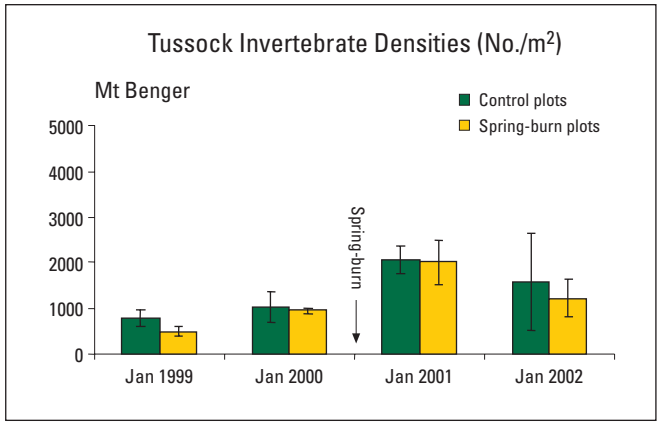




Mt Benger Plots

At **Mt Benger** only the spring burn has taken place. Although some invertebrate groups (e.g., amphipods and true flies) were affected immediately after the burn, sampling the following summer (2001) suggested the fire had had little impact on total invertebrate numbers. However, in 2002 there were noticeably more invertebrates in the unburnt plots than in the burnt plots. This was more marked in intertussock areas.





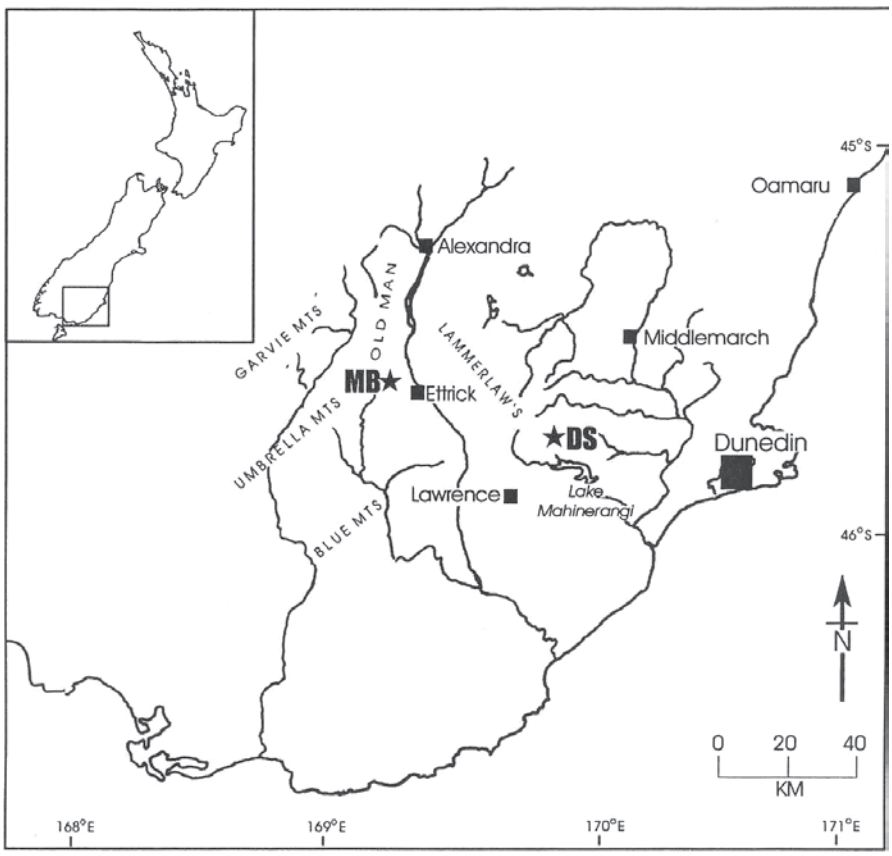
Plans for the coming year

Those of you who have followed the progress of the tussock-fire trials over the last few years will be aware of the difficulties we have had getting the right weather conditions for our spring and summer burns. Two years ago we successfully burned the spring-burn plots at Mt Benger and the summer-burn plots at Deep Stream. Last year we completed the spring burns at Deep Stream, but failed to get the summer plots burned at Mt Benger. This year we'll be trying to get this last set of burns completed. For a summer burn we need a drought code (DC) reading of 200–300 to ensure that the vegetation and soils are sufficiently dry to represent average summer or autumn conditions in the grasslands, but not so dry as to pose an extreme fire risk. Both the Deep Stream and Mt Benger sites have climate stations that are part of the National Rural Fire Weather network. This gives us the ability to track changes in the Fire Weather Indices on a daily basis. For those of you with Internet access the address for this fire-weather information is http://nrfa.fire.org.nz/fire_weather/Index.htm

While the fires are the part of the project that receives the most media attention, the bulk of the work revolves around repeated sampling and measuring, analysing the data, and trying to interpret the results. On the vegetation side Ian Payton, Peter Espie and colleagues will be continuing to measure the changes in species composition and the rate at which the biomass recovers after the burns. Colin Ferguson and Barbara Barratt's group will be continuing to track changes in the invertebrate communities. Funding for this part of the project has been under threat recently but just before Christmas it received at least a temporary reprieve. Department of Conservation rural fire crews with assistance from local authority and forestry personnel will supervise the burns, and Grant Pearce and his fire research team will determine the conditions under which the grasslands are burned.

If you would like more information about the project, have thoughts about how we might improve or enhance aspects of the work, or would like advanced warning of our intention to burn, you can contact me by

Mt Benger and Deep Stream study sites.



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