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Appendix 1

GLOSSARY OF TERMS

Class A foam

A chemical concentrate added to water that combines foaming and wetting agents specifically formulated for extinguishing vegetation.

CIMS

Coordinated Incident Management System. A structure to systematically manage incidents.

Conservation area

Has the same meaning as in the Conservation Act 1987, and includes land being managed under section 61 or section 62 of the Act; but does not include any marginal strip as defined in section 2(1) of that Act.

Control

The overall direction of response activities in an emergency situation. Authority for control is established in legislation or by agreement and carries with it the responsibility for tasking and coordinating other agencies. Control relates to situations and can operate at either the single agency level or horizontally across agencies. (See 'CIMS'.)

Ecosystem

The interacting system of a biological community, including the plants and animals, and its non-living surroundings.

Extreme fire behaviour

A level of fire behaviour that ordinarily precludes methods of direct suppression. One or more of the following characteristics is usually involved: high rates of spread and fire intensity; prolific crowning and/or spotting; presence of fire whirls; a strong convective column.

Fire

Simultaneous release of heat, light and flame, generated by the combustion of flammable material.

Fire authority (taken from the Forest and Rural Fires Act 1977)

Means:

(a) In relation to a rural fire district, the rural fire committee in which the administration of the district is vested or, as the case may be, the Minister of Conservation or the Minister of Defence.

(b) In relation to a territorial area, the territorial authority having jurisdiction in respect of that area.

(c) In relation to any State area, the Minister of Conservation.

(d) In relation to the fire safety margin of any State area, the Minister of Conservation to the extent provided by section 14(5) of this Act.

(e) In relation to any land or other property subject to any agreement or arrangement made pursuant to subsection (1) or subsection (2) of section 14 of this Act, the party thereby appointed to act.

Provided that the power and duties of that party as a Fire Authority shall extend only as far as is provided by that agreement or arrangement.

(f) In relation to any land or other property in respect of which a local authority exercises the functions of a Fire Authority pursuant to section 9(b) of this Act, that local authority to the extent approved under that section by the New Zealand Fire Service Commission.

Fire behaviour

The manner in which fuel ignites, flame develops and fire spreads and exhibits other related phenomena as determined by the interaction of fuels, weather and topography.

Fire break

A natural or artificial physical barrier against the spread of fire from or into any area of continuous flammable material.

Fire climate

The composite pattern or integration over time of the fire weather elements that affect fire occurrence and fire behaviour in a given area.

Fire control (taken from the Forest and Rural Fires Act 1977)

In relation to forest, rural and other areas of vegetation, it means:

(a) The prevention, detection, control, restriction, suppression and extinction of fire.

(b) The safeguarding of life and property from damage and risk of damage by or in relation to fire.

(c) All measures conducive to or intended to further or effect such prevention, detection, control, restriction, suppression, extinction or safeguarding and 'fire control measure' has a corresponding meaning.

Fire danger

A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control and fire impact. (See 'Fire hazard', 'Fire risk'.)

Fire danger rating

The process of systematically evaluating and integrating the individual and combined factors influencing fire danger represented in the form of fire danger indices.

Fire ecology

The study of the relationships between fire, the physical environment and living organisms.

Fire environment

The surrounding conditions, influences and modifying forces of topography, fuel and fire weather that determine fire behaviour.

Fire hazard

A general term to describe the potential fire behaviour, without regard to the state of weather-influenced fuel moisture content and/or resistance to fireguard construction for a given fuel type. This may be expressed in either the absolute (e.g. 'cured grass is a fire hazard') or comparative (e.g. 'clear-cut logging slash is a greater fire hazard than a deciduous cover type') sense. Such an assessment is based on physical fuel characteristics (e.g. fuel arrangement, fuel load, condition of vegetation, presence of ladder fuels). (See 'Fire danger', 'Fire risk'.)

Fire hazard reduction

Treatment of living or dead forest fuels to diminish the likelihood of a fire starting and to lessen the potential rate of spread and resistance to control.

Fire management

All activities associated with the management of fire-prone land, including the use of fire to meet land management goals and objectives.

Fire plan

A statement compiled and issued by a Fire Authority defining policy, chain of command and procedure, in relation to fire control by that Authority.

Fire prevention

Activities directed at reducing fire occurrence; includes public education, law enforcement, personal contact and reduction of fire hazards and risks.

Fire protection

All activities designed to protect an area (including human life, property, assets and values) from damage by fire.

Fire regime

The history of fire use in a particular vegetation type or area including the frequency, intensity and season of burning. It may also include proposals for the use of fire in a given area.

Fire retardant

A chemical substance that, when mixed with water and applied to vegetation, retards fire ignition. Retardants are applied to unburnt vegetation ahead of a fire. (See 'Fire suppressant'.)

Fire risk

The probability or chance of fire starting determined by the presence of activities or causative agents (i.e. potential number of ignition sources). (See 'Fire hazard', 'Fire danger'.)

Fire safety margin

Any land (not being the whole or part of a defence area within the meaning of the Defence Act 1990) that:

> *In relation to a State area, is outside that area but within 1 kilometre (or such less distance as may be approved by the Minister of Conservation, after consultation with the National Rural Fire Officer, and notified in the Gazette) of the boundary of that area.*
>
> *In relation to a forest area, is situated outside that area but within such distance (not exceeding 1 kilometre) of the boundary thereof as is approved by the Fire Authority of that area.*
>
> *But does not include any land that, by notice in the Gazette under section 14(5A) of the Forest and Rural Fires Act 1977, is excluded from the fire safety margin of any State area.* (DOC 2000)

Fire season

The period(s) of the year during which fires are likely to occur, spread and do sufficient damage to warrant organised fire control. There are three types of status—Open, Restricted and Prohibited fire seasons.

Fire Service

The New Zealand Fire Service as constituted by section 3 of the Fire Service Act 1975.

Fire services

Collective term for urban, rural, industrial or defence fire brigades, or fire services, airport rescue services and the New Zealand Fire Service.

Fire suppressant

An additive designed to reduce the surface tension of water and/or to hold water in suspension thus increasing water's efficiency as a fire extinguishing agent. Suppressants are applied directly to the burning fuels. (See 'Fire retardant'.)

Fire suppression

All the work and activities connected with fire-extinguishing operations, beginning with discovery and continuing until the fire is completely extinguished.

Fire weather

Collectively, those weather parameters that influence fire occurrence and subsequent fire behaviour (e.g. dry-bulb temperature, relative humidity, wind speed and direction, precipitation, atmospheric stability, winds aloft).

Fire weather index (FWI) system

The FWI system provides numerical ratings of relative vegetation fire potential. The first three components are fuel moisture codes that follow daily changes in the moisture contents of three classes of forest fuel with different drying rates. The higher values represent lower moisture contents and hence greater flammability. The final three components are fire behaviour indices, representing rate of spread, amount of available fuel and fire intensity; their values increase as fire weather severity worsens.

The system is dependent on weather only and does not consider risk, fuel or topography. It provides a uniform method of rating fire danger throughout New Zealand. The components are described below.

Fine Fuel Moisture Code (FFMC): A numerical rating of the moisture content of litter and other cured fine fuels. This code is an indicator of the relative ease of ignition and flammability of fine fuel.

Duff Moisture Code (DMC): A numerical rating of the average moisture content of loosely compacted organic layers of moderate depth. This code gives an indication of fuel consumption in moderate duff layers and medium-size woody material.

Drought Code (DC): A numerical rating of the average moisture content of deep, compact, organic layers. This code is a useful indicator of seasonal drought effects on forest fuels, and amount of smouldering in deep duff layers and large logs.

Initial Spread Index (ISI): A numerical rating of the expected rate of fire spread. It combines the effects of wind and FFMC on rate of spread without the influence of variable quantities of fuel.

Buildup Index (BUI): A numerical rating of the total amount of fuel available for combustion that combines DMC and DC.

Fire Weather Index (FWI): A numerical rating of fire intensity that combines ISI and BUI. It is suitable as a general index of fire danger throughout the forested and rural areas of New Zealand.

Firefighter

A person whose principal function is fire suppression.

Flammability

The relative ease with which a substance ignites and sustains combustion.

Foam

See ‘Class A foam’.

Fuel

Any material such as dead and live vegetation that can be ignited and sustain a fire.

Fuel load

The dry weight of combustible materials per unit area. Measured in kilograms per square metre (kg/m^2) or tonnes per hectare (t/ha).

Fuel management

Any manipulation (including lopping, mowing, burning and changing of species) for the purpose of reducing their flammability.

Fuel type

An identifiable association of fuel elements of distinctive species, form, size, arrangement or other characteristics that will exhibit characteristics fire behaviour under specified burning conditions.

Ignition

The beginning of flame production or smouldering combustion; the starting of a fire.

Local authority

Any territorial authority within the meaning of the Local Government Act 1974.

Monitor

To check, supervise, observe critically or record the progress of an activity, action or system on a regular basis in order to identify change.

National Rural Fire Authority (NRFA)

The National Rural Fire Authority constituted under section 14A(1) of the Fire Service Act 1975.

New Zealand Fire Danger Rating System (NZFDRS)

The meaning is set out in section 63 of the Forest and Rural Fires Act 1977.

Retardant

A substance that by chemical or physical action reduces the flammability of combustibles and remains effective after application, even after water content has evaporated. Long-term retardants depend on certain flame-inhibiting chemicals for their effectiveness.

Risk

The chance of something happening that will have an impact on objectives. Measured in terms of consequences and likelihood.

Rural Fire Management Code of Practice

The code of practice published under section 14A(2)(e) of the Fire Service Act 1975.

Shrublands (= scrub)

Indigenous shrub species manuka, kanuka, non-merchantable species and may include gorse, bracken, fern, broom, blackberry or other introduced species. May contain regenerating native bush.

Social research

Social research includes research and studies of people. Its subjects can include perception of fire, public awareness and fire prevention, volunteers, historic work into past fires, firefighter health, and cultural issues. It also includes community resilience to fire and restoration of communities after a fire event.

State area

An area of land defined under the Forest and Rural Fires Act 1977, Section 2

Suppress a fire

Extinguish a fire or confine the area burning within defined boundaries.

Threat

The comparative level of the combined effects of risk, hazard and values.

Urban–rural interface

The line, area or zone where structures and other human development adjoin or overlap with undeveloped bush-land.

Values (= values at risk)

The specific or collective set of natural resources and man-made improvements and/or developments that have measurable or intrinsic worth and that could or may be destroyed or otherwise altered by fire in any given area (includes social, economic, cultural and environmental values).

Vegetation

Includes:

(a) All plants and the produce thereof, live or dead, standing, fallen, windblown, cut, broken, pulverised, sawn, or harvested, natural or disturbed, in use or as waste, rubbish, refuse or debris, stump, stubble, or otherwise

(b) Fossil fuel exposed at or lying within 20 metres of the surface of any land

(c) Peat in any form.

But it does not include wood forming part of a structure or in an otherwise processed form. (Forest and Rural Fires Act 1977, Section 2)

Wildfire

An unplanned fire. A generic term that includes grass fires, forest fires and shrubland fires.

Wildfire threat analysis

A systematic method of identifying the level of threat a particular area faces from wildfire. The level of threat is generally related to a combination of ignition potential, potential fire behaviour and the values threatened. These factors may themselves be derived from other combinations of factors, for instance, potential fire behaviour can be determined from a combination of climate, topography and fuels.

Appendix 2

PROJECT METHODOLOGY

A2.1 Introduction

A Terms of Reference for this project was prepared in July 2005 (Hilliard & Hunt 2005). The agreed process was to visit and interview DOC staff and people working in other agencies. Following a request from a wider group of DOC staff wishing to take part in face-to-face discussions, the original number of localities to visit was expanded from 9 conservancies to include all 13. The RD&I offices in Hamilton, Wellington and Christchurch were also visited.

Eighty DOC staff were interviewed and 46 questionnaires completed. These included 2 written 'interviews', 5 telephone interviews, 14 one-on-one sessions, and 15 group sessions. The positions of DOC staff extended from Rangers to Conservators and Principal Business Analysts (see Table A2.1 below). Ten questionnaires were also completed during six one-on-one interviews and four group sessions with staff working for other agencies.

TABLE A2.1. COMPOSITION OF INTERVIEWEES.

DOC STAFF POSITIONS	NUMBER	NON-DOC ORGANISATIONS	NUMBER
Conservator	4	Landcare Research (scientists)	7
Technical Support Manager	7	National Rural Fire Authority	4
Technical Support Officer (Advisory Scientist)	6	Ensis (fire scientists)	3
Technical Support Officer[a] (Fire)	12	AgResearch	2
Technical Support Officer[a] (Pests and Threats, etc.)	25	**Total non-DOC people**	**16**
Information Management Unit[b] staff	3		
Area Manager	4		
Programme Manager	6		
Ranger	1		
Scientist	8		
Principal Business Analyst	2		
Internal Auditor	1		
National Fire Coordinator	1		
Total DOC staff	**80**		

[a] A Technical Support Officer is a specialist who provides support to the conservancy staff.
[b] Information Management Units are staffed by geospatial specialists who use GIS.

A2.2 Interviews with DOC staff

Selection: On 12 July, Conservators were notified of the project and that initial contact would be made through the Technical Support Managers. All Technical Support Managers were rung and meeting times were set, based on people's availability. The Technical Support Officer (Fire) (or representative) in each conservancy was also contacted.

Outcome: Some conservancies publicised the project well and interested staff programmed the time into their diaries. Other conservancies appeared to select only a few key staff and, when the meeting times were set, a number could not attend, which limited the meeting's effectiveness. Some key individual staff were difficult to contact. Also, in some conservancies, fire management appears to be seen as just fire suppression, and staff were considered to be adequately trained. Any further work on fire research was not seen as important.

A2.3 Interviews with non-DOC organisations

Selection: Because there are only a few organisations directly managing rural fires and fire research, getting in contact with them was easy.

Outcomes: Key known individuals and organisations were contacted and dates and times for meetings set. There were no issues with this process and the participants were interested and willing to be involved.

A2.4 Names of people interviewed

The people interviewed are listed in Table A2.2.

TABLE A2.2. NAMES, ROLES AND LOCATIONS OF INTERVIEWEES.

NAME	ROLE	LOCATION
Chris Jenkins	Conservator	Whangarei
Don McKenzie	Technical Support Manager	Whangarei
Tony Beauchamp	Conservancy Advisory Scientist	Whangarei
Tony McCluggage	Technical Support Officer (Weeds)	Whangarei
Lisa Forester	Technical Support Officer (Plants)	Whangarei
Lynnell Greer	Technical Support Officer (Recreation)	Whangarei
Peter Anderson	Technical Support Officer (Species)	Whangarei
Terry Conaghan	Information Management	Whangarei
Trevor Bullock	Technical Support Officer (Fire)	Bay of Islands
Alan MacRae	Ranger	Kaitaia
Jan Coates	Technical Support Manager	Auckland
Chris Green	Technical Support Officer (Invertebrates)	Auckland
Bec Stanley	Technical Support Officer (Plants)	Auckland
Daniel Breen	Conservancy Advisory Scientist	Auckland
Nobbie Reekie	Technical Support Officer (Fire)	Auckland
Peter de Lange	Scientific Officer	RD&I Auckland
John Gumbley	Technical Support Manager	Waikato
Avi Holzapfel	Conservancy Advisory Scientist	Waikato
Michael Green	Technical Support Officer (Fire)	Waikato

Continued on next page

Table A2.2—continued

NAME	ROLE	LOCATION
Andrea Brandon	Technical Support Officer (Plants)	Waikato
Ian Imrie	PM Service	Hauraki
Tracie Dean	Manager (Freshwater)	RD&I Hamilton
Natasha Grainger	STSO	RD&I Hamilton
Simon Kelton	Principal Business Advisor	RO Hamilton
Brendon Christensen	Technical Support Officer (Monitoring)	Bay of Plenty
Ralph Turner	Technical Support Officer (Fire)	Bay of Plenty
Bob Boardman	Technical Support Officer (Fire)	Bay of Plenty
Harry Keys	Conservancy Advisory Scientist	Tongariro
David Lumley	Area Manager	Tongariro
Nick Singers	Technical Support Officer (Plants)	Tongariro
Trevor Mitchell	Technical Support Officer (Fire)	East Coast
Chris Ward	Technical Support Officer CAS	East Coast
Ken Hunt	Area Manager	Napier
Ed Te Kahika	Field Supervisor	Napier
Paul Baker*	Rural Fire Manager	Napier
Bill Fleury	Technical Support Manager	Wanganui
Lindsay Golding	Technical Support Officer (Fire)	Palmerston North
Bill Carlin	Conservator	Wanganui
Amy Hawcroft	Technical Support Officer (Ecology)	Wanganui
Robert Bennett	Area Manager	Stratford
Phil Mohi	Area Manager	Palmerston North
Graeme La Cock	Technical Support Officer (Plants)	Wanganui
Kerry Hilliard	National Fire Officer	Palmerston North
Jim Campbell	Programme Manager (Biodiversity)	Wanganui
Rod Smillie	Programme Manager (Biodiversity)	Wanganui
John Mangos	Land Management Officer	Defence Department, Waiouru
Colin Miskelly	Technical Support Manager	Wellington
Rachael Thorp	Technical Support Officer (Fire)	Wellington
John Sawyer	Technical Support Officer (Plants)	Wellington
Hilary Aikman	Technical Support Officer	Wellington
Paul Hughes	Information Management	Wellington
Don Newman	Science Manager	Wellington
Susan Timmins	Scientific Officer	Wellington
Kate McAlpine	Scientific Officer	Wellington
Mike Davies*	Manager Legislation/Operations	NRFA Wellington
Karl Majorhazi*	Information Management	NRFA Wellington
Murray Dudfield*	National Rural Fire Officer	NRFA Wellington
Martin Heine	Technical Support Manager	Nelson
Mike Rodgers	Technical Support Officer (Fire)	South Marlborough
Shannel Courtney	Technical Support Officer (Plants)	Nelson
Cathy Jones	Technical Support Officer (Plants)	Nelson
Ian Miller	Technical Support Officer (Invertebrates)	Nelson
Harri Rautjoki	Auditor	Nelson
Elaine Wright	Terrestrial Sites Manager	Christchurch
Rod Hay	Science Manager Threats	Christchurch
Graeme Ayres	Principal Business Advisor	Christchurch

Continued on next page

Table A2.2—continued

NAME	ROLE	LOCATION
Dave Wilkins	Acting Technical Support Manager	Christchurch
Sjaan Charteris	Technical Support Officer (Freshwater)	Christchurch
Tony Teeling	Technical Support Officer (Fire)	Christchurch
Andy Grant	Conservancy Advisory Scientist	Christchurch
Nick Head	Technical Support Officer (Plants)	Christchurch
Norm Thornley	Information Management	Christchurch
Richard McNamara	Programme Manager Fire/Compliance and Law Enforcement/Historic, etc.	Twizel
Matt McGlone*	Scientist	LCR Christchurch
Janet Wilmhurst*	Scientist	LCR Christchurch
Peter Bellingham*	Scientist	LCR Christchurch
Ian Payton*	Scientist	LCR Christchurch
Grant Pearce*	Scientist	Ensis Christchurch
Stuart Anderson*	Scientist	Ensis Christchurch
Tonja Opperman*	Scientist	Ensis Christchurch
Ingrid Grunner	Conservancy Advisory Scientist	Hokitika
Jim Staton	Technical Support Officer (Fire)	Hokitika
Philipe Gerbeaux	Technical Support Officer (Freshwater)	Hokitika
Phil Knightbridge	Technical Support Officer (Plants)	Hokitika
Tom Belton	Technical Support Officer (Weeds/WAC)	Hokitika
Jeff Connell	Conservator	Dunedin
Marcus Simons	Technical Support Manager	Dunedin
Brin Barron	Technical Support Officer (Fire)	Alexandra
John Pearce	Programme Manager (Biodiversity Threats)	Dunedin
Theo Stephens	Scientific Officer	Dunedin
Geoffrey Rodgers	Scientific Officer	Dunedin
Bill Lee*	Scientist	Landcare Dunedin
Susan Walker*	Scientist	Landcare Dunedin
Peter Johnson*	Scientist	Landcare Dunedin
Barbara Barrett*	Scientist	AgReaearch Dunedin
Colin Fergusson*	Scientist	AgResearchDunedin
Alan Jackson*	Rural Fire Manager	NRFA Dunedin
Brian Rance	Technical Support Officer (Plants)	Southland
Peter Lowen	Programme Manager (Biodiversity)	Southland
Andrea Goodman	Technical Support Officer (Fauna)	Southland
Lynn Sheldon-Sayer	Ranger Weeds	Southland
Mike Grant*,†	Principal Rural Fire Officer	Southland
Chris Hodder	Fire Operations Officer	Victoria, Australia

* Non-DOC personnel.

† Manages Southland Conservancy's fire responsibilities.

A2.5 Fire research needs questions for DOC staff

Name	Location
Date	Time in position

Introduction

The objectives of this review are to complete a Fire Management fire research needs analysis for the Department of Conservation taking into account the findings of the internal audit into fire management systems. This includes:

1. Identifying the current and future fire research needs of the Department;
2. Consider the current and future fire research being carried out in New Zealand and the Australian Bushfire CRC that directly relates to the department;
3. Assessing the 'gap' between the Department's needs, 'awareness' and the current research environment;
4. Identifying approaches the Department can use to ensure adequate and appropriate fire research, including fire ecology, is undertaken that can be applied to fire management;
5. Identify, describe and recommend future technical advice requirements relating to fire ecology for the DOC to manage its obligation in Protected Natural Areas.

1. What type of Interview?	Telephone: One on One: Group:
2. What is your role within the Department and what is your relationship with fire management?	
3. Do you know of any fire research projects in New Zealand? If Yes which ones? What is the intent?	
4. Two questions, current and future research needs. What do you consider are the current fire research needs for the Department? How can these be addressed?	Current needs Addressed by
5. What do you consider are the future fire research needs for the Department? How can these be addressed?	Future needs Addressed by
6. What ecosystems in your conservancy (or area of work) are most prone to fire?	
7. What research, if any, do you need to support management of these ecosystems?	

8. Do you monitor ecosystem recovery after fires?
   If yes how?

9. Can you identify three aspects of fire research you would like to see that would make the biggest difference to the Department's fire management?

10. What future technical advice on fire ecology is needed by the Department?

    How do you see this being implemented?

11. Anything else you would like to say?

A2.6 Fire research needs questions for non-DOC personnel

1. What type of Interview?	Telephone: One on One: Group:
2. What is your organisation's role in fire management?	
3. Do you know of any fire research projects in New Zealand? If Yes which ones? What is the intent? Attach notes/papers if necessary	
4. What national social, ecological or physical research relating to fire management, needs to be undertaken in New Zealand?	National needs:
How will these be addressed and by whom?	Addressed by
5. Can you identify three aspects of fire research that would make the biggest difference to national fire management in New Zealand?	
6. What future technical advice on fire management do you feel is needed by the Department of Conservation?	
How do you suggest this should be implemented?	Implemented by:
7. Anything else you would like to say?	

Appendix 3

GOVERNMENT FUNDING FOR RESEARCH IN AUSTRALIA

(Material taken from the Bushfire CRC website, www.bushfirecrc.com, viewed July 2007.)

Wildfire research—science for safer communities

The Bushfire Cooperative Research Centre (CRC) was established under the Australian Commonwealth Government's CRCs Programme. The objective is to provide research that enhances the management of the bushfire risk to the community in an economically and ecologically sustainable way.

Aims of the Bushfire CRC

- To develop an internationally renowned centre of excellence to lead and coordinate bushfire research in Australia
- To provide a research framework that will improve the effectiveness of bushfire management agencies
- To increase the self-sufficiency of communities in managing the risks from bushfires

The Bushfire CRC runs four separate research funding programmes. Each of the research programmes is described below:

A: Safe prevention, preparation and suppression

B: Management of prescribed and wild fires in the landscape

C: Community self-sufficiency for fire safety

D: Protection of people and property

It also has an education and training programme, which provides scholarships (Programme E), as well as a knowledge networking programme (Programme F).

Programme A: Safe prevention, preparation and suppression

This category of research aims to increase understanding of, and ability to manage, bushfires in order to reduce the risk to firefighters and the community.

Accurate, high-resolution fire weather and fire behaviour predictions are key to taking effective management action before and during fires. There is a need to more accurately describe the fire environment and the level of uncertainty in predictions, so that fire managers can better understand the consequences of their actions, and of their interaction with natural events.

Reliable predictions of different elements of fire behaviour and fire danger are critical in suppression strategies. Diurnal, short-term (up to 4 days), seasonal and long-term predictions of potential fire occurrence and severity are also critical for allocating fire-fighting resources, implementing prescribed burning programmes and for public warning and fire migration programmes.

The duty of care principles constraining bushfire and prescribed fire management across a widening range of social and environmental issues requires that the fire manager uses reliable prediction tools that make the best use of emerging technology. Advances in computing and knowledge-based systems will greatly facilitate the integration of more of the critical variables that determine the development of either wildfire or controlled prescribed bushfire. The challenge will be to determine which are the most relevant factors from all the available sources and then subject these to rigorous field testing.

Programme A is divided into five major research themes. Each has a range of research projects, postdoctoral research fellows, postgraduate studies, end-user collaboration and national and international links. The five themes are:

A1. Fire behaviour modelling, with sub-themes:

- 1.1 Fire behaviour modelling (because of its relevance, this sub-theme is described more fully below)
- 1.2 Bushfire observer's handbook
- 1.3 Fuel classification and availability
- 1.4 Improved methods for assessment and prediction of grassland curing

A2. Fire weather and fire danger

A3. Suppression technology

A4. Bushfire risk management

A5. Computer simulation modelling

Projects aligned with these themes are led by researchers from CSIRO, the Commonwealth Bureau of Meteorology, and the Universities of Melbourne, New South Wales and Western Australia. Programme A has established an end-user advisory committee to strengthen the important link between researchers and users.

Programme A1-1.1: Fire behaviour monitoring

The need to improve firefighter and community safety in the management of bushfires has been a growing concern in recent years. This project aims to address this need by providing better knowledge and understanding of the interactions between fire, fuel, weather and topography.

The project plans to integrate existing and new fire behaviour models into a national fire behaviour prediction system. Factors include rate of spread, flame height, intensity and spotting for wildfires and controlled prescribed fires. The research includes experimentation and validation of fire behaviour models, documentation, training, and the production and delivery of fire behaviour systems to end users.

Specifically, research includes field validation of the findings from Project Vesta to southeastern fuels in Maragle State Forest, NSW. Project Vesta was a comprehensive research project between CSIRO, Department of Conservation and Land Management in Western Australia that investigated the behaviour of bushfires burning fuel of different ages and structures under dry summer conditions. Experimental burning and the collection of fire behaviour information from major wildfires is a key component of the research. (See website: www.ffp.csiro.au/nfm/fbm/vesta, viewed 8 October 2006.)

A highlight of the work was a large-scale experimental burn named 'Operation Tumbarumba', which was conducted in Maragle State Forest, adjacent to Kosciusko National Park in February 2004. This was the first experimental burn conducted in the life of the Bushfire CRC and was notable because it was linked with other research projects, such as the Fuel Classification and Tanker Systems projects. The experiment involved more than 20 researchers and 60 personnel from the NSW Rural Fire Service (staff and volunteer firefighters), Country Fire Authority Victoria (staff and volunteer firefighters), state forests of New South Wales, New South Wales National Parks and Wildlife Service, Department of Sustainability and Environment Victoria, Department of Conservation and Land Management, Western Australia, and New Zealand Ensis.

A postgraduate scholarship at the University of New South Wales (ADFA) was also established as part of this project to investigate the weather and fuel moisture parameters affecting the behaviour of fires in heathland fuels in the greater Sydney Basin Region.

Project synopsis

The programme will link with other research to integrate both physical and empirical models to develop operational fire behaviour models for varied vegetation types. The projects will give managers better operating models to implement prescribed burning programmes, suppression resources, risk and biodiversity management programmes. These models will be integrated into a national fire behaviour prediction system consisting of four primary components (fuel models, fuel moisture models, wind models and spot fire models) to predict fire behaviour, including rate of spread, flame height, fireline intensity and residence time.

High-resolution fire behaviour prediction is crucial to taking effective fire management action before and during fires. Models need to accurately describe the fire environment—and indicate the uncertain level of predictions—so fire managers can better understand the likely consequences of their actions. Predictions of different elements of fire behaviour, including emissions, are vital when deciding on suppression strategies.

The first of three core projects involves extending the forest fire behaviour model derived from the Project Vesta fire experiments in WA to suit conditions in southeast Australia. Researchers will compare fuels of different ages in selected eucalypt forests in southeast Australia with those from the WA fire experiment sites. Wind data from the Bureau of Meteorology weather prediction models will be compared with observations taken below the forest canopy to calibrate and validate the fire behaviour models. Techniques will be developed to collect wildfire data to extend the fire behaviour datasets into very high and extreme fire danger conditions. Field validation fire experiments will be carried out in the Margle State Forest.

The second focus will be on extending a preliminary model for predicting fire behaviour in heathland, shrubland and woodland. This vegetation makes up a considerable proportion of the remaining natural vegetation in the most heavily populated parts of Australia, and is a major component of the urban interface around Sydney. Carefully designed experimental fires will isolate the effects of vegetation type, structure and age, and will examine fire behaviour at low moisture contents. The effects of slope and head fire width will also be determined. Bushfire data must be collected to validate the model for high intensity conditions.

The third research goal is to determine a prescribed burning protocol for forest plantations. The Plantations for Australia 2020 vision (www.plantations2020.com.au, viewed August 2006) of trebling the plantation estate to 3 million hectares will significantly change the nature and load of flammable fuels and consequently alter regional fire risk and fire behaviour. Researchers will develop prescribed burning guides for different plantations in the north coast region of NSW, and will create new fire behaviour models to help fire and plantation managers plan for pre-suppression and suppression activities.

Project Leader: Jim Gould, CSIRO, Ph: (02) 6281 8341.

Programme B: Management of fire in the landscape

Managing fires on a landscape scale is a difficult task in a continent where fire is a central component of both the ecology and the biophysical 'structure' of the environment. This programme focuses on the use of prescribed fires to prevent loss of life and property, and to retain key ecological attributes such as biodiversity. Embracing prescribed fire as a central plank in maintaining biodiversity has been one of the major shifts in government policy in recent years and a testament to the work of many scientists over many years. However, the job is not finished and progress in Programme B during the first year of the CRC's operation has largely been the continuation of research already underway.

The CRC looks forward to further dialogue on how to best integrate the outputs and learning from Programme B into practice. Recent launches of books and research projects in Sydney and Darwin have attracted broad media and community interest.

Another important outcome in this early part of the CRC's life has been the recruitment of key postdoctoral researchers. New young researchers in Programme B include Matthias Boer, Roy Witkuhn, Maria Taranto, Karen King and Kate Parr. It is significant that two are international—Matthias Boer from Spain, and Kate Parr from South Africa.

Literature reviews will feature highly as outputs of several current research projects. These are eagerly awaited by both the CRC research committee and the stakeholders. Programme B research spans Australia—from Darwin to Perth to Adelaide to the entire eastern seaboard. It also spans nearly every imaginable type of Australian ecosystem, and includes research conducted within long-term fire regime experiments, as well as that conducted 'opportunistically'. Some of the NSW and WA research aiming to develop landscape-scale use of fire history data in conjunction with biodiversity and other ecological data offers exciting prospects for CRC's stakeholders. Equally exciting are the prospects of a world-class facility for analysis of bushfire smoke, and the related development of a database.

Programme C: Community self-sufficiency for fire safety

Some members of these communities may also create risk by starting fires through carelessness or arson. Through individual and community action people can reduce their own vulnerability, and reduce the probability of fires, and substantially reduce fire's impact. Communities need support to achieve this, and agencies involved with bushfire risk management need to know how best to provide it. They need to be confident that programmes work and that they are cost effective.

Programme C has started to address these issues through projects on:

- Understanding communities
- Risk communication
- Negligent and deliberate fire lighting
- The economics of bushfire
- The 'stay-or-go' policy
- The evaluation of community safety policies and programmes

Projects in this programme draw primarily on social science and economics. Each project or project area is working towards two basic aims:

- A state of the art methodology, or guidelines for the specific topic
- The evaluation of selected existing practices through case studies

The projects are closely linked to other CRC activities, in particular parts of Programme D on building safety, Programme A on aerial fire fighting, and all areas with an interest in bushfire risk modelling. Initial reports and presentations have been produced in the first year and next steps include finalising reports for publication, and commencing primary data collection and analysis, which will involve case studies and collation of disparate datasets.

This work has attracted considerable international interest. Collaboration has commenced in the economics area and is also expected soon in the 'stay-or-go' project.

Programme C aims to increase community resilience through self-sufficiency in managing bushfire risk. People living and working in bushfire-prone areas bear the fire risk and also, through their lifestyles and locations, help create the risk.

Programme D: Protection of people and property

The risk to people and the destruction of property by bushfires in Australia are major political issues. Community expectations change with time and so does the impact of bushfires. Living in the high-risk urban interface is now a much sought after lifestyle for a large proportion of Australians, and the ability of new arrivals to cope with bushfires is often inadequate. In addition, community expectations for the health and safety of firefighters are now higher than they were even a decade ago. Working conditions on the fireground are now expected to be as safe as those in a normal work place.

The need for a risk model

A key focus of this programme is developing a risk model for assessing the impact on houses and thence the cost effectiveness of various recommendations related to safety. The numerous factors under study that affect safety include climate factors, the terrain and vegetation landscape within a kilometre or so of houses, local urban planning and building regulation requirements, details of house construction, local fire fighting policies and the preparations and actions of the building occupants themselves. In addition, laboratory studies will be undertaken to develop methods for the design of various building components, such as decking and glazing, to resist attack by bushfires.

Firefighter health and safety

The largest part of this programme targets the health and safety of firefighters. Both short-term risks and long-term health hazards will be investigated. Initially, the demographics and data on the physiology of Australian firefighters will be obtained. These will be used to map out strategies for work routines, which will then be checked by field measurements under operational conditions. Of particular concern is the health impact of air toxics in the fireground, where many potentially hazardous chemicals are detected. Improvements in fire-fighting equipment are also being investigated as part of the safety drive. One such project has assessed the performance of fire-fighting trucks that have been modified to provide protection in the event of an accidental burn-over from a moderate forest fire. A project is also underway to assist firefighters in making safe decisions, particularly when subjected to the stress of operational situations.

Volunteerism

The recruitment and retention of volunteer firefighters is seen as a major issue in the protection of people and property. Currently Australia is serviced by about 300 000 highly effective volunteers and their services, which if paid for, would cost several billion dollars each year. The indications are that the size and nature of this volunteer work force will change in the future owing to changes in the demographics and culture of those living in rural and peri-urban areas. Accordingly, research is underway to assess the changes and to develop strategies for dealing with them.

Appendix 4

ENSIS BUSHFIRE COOPERATIVE RESEARCH CENTRE PROJECTS

This appendix provides supporting information to section 5 of this report. It summarises three funding streams that provide opportunities for a range of fire management research projects in New Zealand. It also summarises projects underway at October 2005.

The three funding providers are the:

- Foundation for Research, Science and Technology (FRST) research programme (see Appendix 5 for further detail of the FRST programme)
- Australian Bushfire Cooperative Research Centre (CRC) programme
- New Zealand Rural Fire Research Group projects

A4.1 FRST research programme

This 6-year research programme began in 2005. The programme has four themes, which are listed below.

Reduction of wildfire hazard

These projects aim to quantify factors contributing to wildfire risk by providing:

- Better definition of the rural fire hazardscape and the physical and human/social processes contributing to vegetation wildfires, leading to improved wildfire risk assessments
- Quantification of the physical/environmental factors (fuels, weather, topography) that contribute to rural fire risk
- Assessment of the social/political/economic factors that may contribute to the fire hazardscape in rural areas
- Analysis of data on fire frequency, causes, area burned and costs

Application of fire danger rating to enhance readiness

These projects focus on developing a New Zealand Fire Danger Rating System (NZFDRS), modelling fire behaviour and communicating fire danger through the:

- Development and validation of the FWI (Fire Weather Index), FBP (Fire Behaviour Prediction) and FOP (Fire Occurrence Prediction) modules of the NZFDRS
- Development of models to predict rate of fire spread and fuel consumption in a range of vegetation types
- Determination of the effectiveness of communication of fire danger warnings in reducing fire hazard and ensuring the safety of communities in rural areas

Tools to support wildfire response

These projects aim to develop practices and tools that promote safe and effective decision making during rural fire incidents, with particular emphasis on improving firefighter and community safety, through the:

- Quantification of resource productivity and fire suppression effectiveness during wildfires and research burning trials
- Production of models and guidelines for predicting the productivity and effectiveness of fire suppression resources
- Development of models and guidelines for predicting the effectiveness of fire breaks in different fuel types
- Development of spatial tools to model fire growth to support fire suppression decision-making

Social research on improved community recovery mechanisms

These projects seek to quantify the effectiveness of existing recovery processes following wildfires, and investigate methods for enhancing community resilience through the:

- Evaluation of community resilience and recovery mechanisms following major fire events (e.g. Blenheim and Alexandra), and documentation of case studies and lessons learned
- Evaluation of relevant international research results and social recovery practices
- Recommendations on best practices to lessen social impacts and improve recovery process following significant wildfires

A4.2 Bushfire CRC projects (Year 3 of 7)

The Australian Bushfire CRC was established in December 2003 to bring together state agencies, research organisations and universities across Australia. It has been allocated A$110 million for bushfire research over 7 years. The New Zealand Fire Research programme has been invited to participate and this carries significant benefits both for its projects and for fire management in general. Benefits include:

- Some funding for research and travel costs
- Access to the education programme and student scholarships
- Access to all research results and outcomes from across the Bushfire CRC

The Bushfire CRC has four research programmes, plus an education programme:

Programme A: Safe prevention, preparation and suppression

Programme B: Management of fire in the landscape

Programme C: Community self-sufficiency for fire safety

Programme D: Protection of people and property

Programme E: Education

New Zealand provides an in-kind contribution to several programmes via existing activities:

- Within Programme A, led by Ensis Bushfire Research (J. Gould)
- Contributing to research on fire behaviour modelling via research burning (A1.1, Project FuSE, further described below)
- Leading research on grassland curing assessment (A1.4, further described below)
- Recently joined Programme C—social research

Bushfire CRC research in 2005

- Wildfire risk, fire occurrence and statistics.
- Description of the New Zealand fire environment—fuels (fuel type definition and mapping) and weather (fire climate description and mapping, and effects of climate change).
- Review of factors affecting wildfire risk (including social/economic factors); review of available information sources and databases; development of work plan for subsequent research.

Project A1.1: Fire behaviour modelling for shrub and heathland fuels

Also known as Project FuSE—'fire behaviour experiments in scrub, with attention to wind (u) and slope'.

- Modelling heath/scrub fire behaviour
  - —In similar shrub/heath types across Australia and New Zealand
  - —In New Zealand, 15–20 burns in manuka/kanuka and gorse scrub at 2–3 sites
- Effects of slope on rate of spread
  - —New Zealand sites on steep slopes critical to research
  - —5–10 burns at 1–2 sites, initially in scrub but also potentially other fuel types (such as tussock)
- First New Zealand burn experiments at Lake Taylor site completed (March 2005)
  - —International research team: CSIRO, CALM-WA, DEH-SA, USFS (Riverside) and the New Zealand Fire Researchers (Ensis)
  - —Three burns in manuka/kanuka scrub on steep slopes (25° to 35°)
  - —Two burns in manuka scrub/wilding pine mix on lesser slopes (5° to 15°)
  - —Included point and line ignition comparisons
  - —Measurements of rate of fire spread, flame lengths, fuel consumption, weather, fuel moisture, in-fire temperatures; and recording of ground and aerial infra-red and visual video
- Further New Zealand burn experiments planned at the Torlesse site
  - —8–10 burns in manuka/kanuka and gorse scrub on range of slopes and aspects
  - —Multi-year burn programme; set up in spring 2005 (from September), first burns proposed summer 2006 (November/December)

Project A1.4: Improved methods for the assessment and prediction of grassland curing

This project began in 2004 to test the degree of curing, i.e. the 'proportion of cured and/or dead material in a grassland fuel complex'. It is providing critical input for Australian and New Zealand models of grassland fire behaviour and fire danger. The project is revealing inaccuracies and inconsistencies with current methods.

Objective: To develop improved methods for the assessment and prediction of grassland curing as an input into fire danger rating systems and fire behaviour models.

Deliverables:

- Accurate curing input into fire danger rating and fire behaviour models
- Systems applicable across a range of grass types, and management and environmental influences
- Assessement of current and prediction of future levels of curing
- Prediction of the onset and progression of curing, and green-up
- Data for use in maps, climatology
- Systems that are easy to use and implement operationally

Research methods:

- Remote sensing
- Pasture growth modelling and soil moisture relationships
- Australasian field sampling programme

A4.3 Rural Fire Research Group projects

These projects are undertaken as part of the FRST research programme.

Fuel type and fuel load mapping

An improved fuel type and fuel loadings project has begun. A Fire Technology Transfer Note on this has been published (Opperman & Coquerel 2005). It is a GIS-based project using Landcover Database 2 data.

New Zealand fire climate and fire behaviour mapping

This maps the fire climate using climate station information, then uses these data to map fire behaviour potential. This is done by combining fuel types and fuel loadings (above), and fire climate models.

Research on wildfire risk, fire occurrence and statistics

This project has two foci:

1. Description of the New Zealand fire environment:
- Fuels: studies of fuel chemistry, fuel type field guide
- Weather: fire climate updating, fire season severity prediction
- Topography: modelling of slope/aspect effects on Finefuel Moisture Code

2. Review of fire occurrence statistics:
- Analysis of data on fire frequency, cause, area burned and costs
- Recommendations on fire occurrence databases and reporting
- Analysis of total costs of wildfires to New Zealand
- Development of the FOP module

Fire behaviour modelling—2004/05 experimental burning

- Focus on Bushfire CRC experiments: completion of Lake Taylor scrub burns, establishment of Torlesse site
- Mt Benger tussock fire ecology burns
- Completion of stubble burns, Canterbury, in conjunction with firebreak breaching studies
- Wildfire documentation: significant fires of 2004/05

Fire behaviour modelling—future

Development of a New Zealand FBP system:

- Observation and documentation of fire behaviour in different vegetation types: experimental burning trials and opportunistic wildfires
- Validation of existing international models: mature pine, logging slash, pasture grasslands
- Development of models for unique New Zealand fuel types: gorse and manuka scrub, tussock grasslands, crop stubble

Grass curing—future

The focus is on two aspects of improved methods for the assessment and prediction of grassland curing.

Investigation of alternative approaches:

- Remote sensing, pasture growth modelling, soil moisture relationships
- Expanded Australasian field sampling programme

Accurate curing inputs for fire danger and fire behaviour models:

- Current and predicted curing; curing onset, the progress of greening-up
- Models/systems for range of grass types, and management and environmental influences

Fire response tools (1)

This looks at resource productivity and effectiveness. It is led by the Centre for Human Factors and Ergonomics (Scion-based research team) and involves:

- A literature review, a work plan and the development of methods for research
- Data collection from experimental burns, wildfires and simulated exercises
- Validation of international resource productivity studies
- Assessment of the effectiveness of firefighters, hand tools, pumps and hose, and heavy machinery

A New Zealand Fire Service Commission Collaborative Research Fund proposal for a project looking at fire suppression workload and firefighter fatigue was unsuccessful.

Upgrading of New Zealand Fire Danger Rating System

This is looking at upgrading and developing NZFDRS modules via:

- FWI system validation
- Ongoing FBP development, including fire behaviour models and grass curing investigations
- FOP and AFM (Accessory Fuel Moisture) system development

It is also looking at developing and improving NZFDRS guides and systems such as those related to fire danger class criteria, the FWI system, the FBP system and the FOP system.

New fire response tools (2)

Firebreak effectiveness studies involve developing a research methodology for firebreak breaching trials via a literature review, and the development of a workplan and a methodology. It is hoped this will be undertaken as student project. A pilot study in crop stubble was carried out during the 2004–05 season. The initial focus is on crop stubble, and the intention is to extend the work to other fuel types (scrub, forest).

The aim is to produce models and guidelines for operational use and to validate international models and guides (e.g. those for grass).

Fire response tools—future

This project to develop spatial fire growth models involves a review of international GIS-based fire spread/growth models via a technical review of the GIS components of available models, and a review of fire behaviour modelling aspects of the available models. It will begin in 2005/06.

It will deliver recommendations on how best to progress New Zealand fire growth models. Its aim is to adopt and/or adapt existing models rather than re-invent them. The completion date is 2009/10 (or earlier).

Social wildfire research

New social fire research is underway in a range of areas:

- Social and economic factors affecting wildfire risk: review of databases, workplan development.
- Communication of fire danger warnings: new research for 2005/06; review of international approaches; investigation of fire manager as compared to public perspectives.
- Community resilience and recovery following wildfire events: two studentships were obtained during 2004/05; reviews of Australian and North American literature; case studies of affected communities planned from 2005/06.

Technology transfer

This has three components:

- Developing fire behaviour training and materials:
  —Intermediate fire behaviour courses
  —Fire behaviour forecasting course (under development)
- Publications:
  —Forest Research Bulletin series
  —Newsletters (Fire Technology Transfer Notes, Fire Research Overview)
  —Other (Fire Behaviour Field Guide)
- Fire Research website:
  —Adding pages on fire background and on publications
  —Updating project pages

Appendix 5

GOVERNMENT FUNDING FOR RESEARCH IN NEW ZEALAND

Organisations, including government departments, can fund and carry out their own research. There is also a government-funded agency that funds research by other organisations—the Foundation for Research, Science and Technology (FRST).

FRST must show measurable returns to New Zealand from its investments. It has determined to do this in part by creating an Outcome Based Investment (OBI) programme where:

- There is clear identification of long-term outcomes
- Long-term investment stability is targeted at areas of national importance
- Science outputs are taken up, applied and the benefits of the research captured
- There is engagement and coordination with research users to achieve practical outcomes
- The research contribution to the delivery of outcomes is monitored and measured

An OBI is an investment tool that focuses on contracting for outcomes (rather than outputs per se). It does this through the delivery of Intermediate Outcomes. FRST defines an Intermediate Outcome as a 'direct, measurable result of successful implementation or uptake of research outputs'.

An OBI is associated with an 8–12-year funding period (rather than the usual 3–5 years), meaning more security for the science provider agencies and a greater opportunity to deliver meaningful natural ecosystem research products. The investment amounts are large (up to NZ$6.2 million per year for 12 years in the most extreme case) and a contestable process is run to select the best providers or mix of providers.

A due diligence round is run on each likely provider to ensure that its capability claims are justified and that the provider is likely to be able to deliver results.

Each OBI is managed under strict project management protocols and is the responsibility of a governing body (a board or a council) to ensure that strategic directions are maintained and priorities actioned. Moreover, each OBI is supported by advisory committees to ensure that the detailed research directions and projects are aligned with governance body expectations. End-user engagement in both governance and advisory levels is mandatory.

Research on four government goals are undertaken by FRST. These are:

- Economic research for industry
- Environmental research
- Knowledge
- Social

Within each goal are Portfolios, each of which has Target Outcomes.

Four Portfolios exist under 'environmental research':

1. Understanding and adapting to global environmental and earth processes change
2. Resilient, functioning and restored natural ecosystems
3. Building sustainable cities and settlements
4. Maintaining environmental integrity for sustainable resource use

Eight Target Outcomes have been identified and funded under Portfolio (2): Resilient, functioning and restored natural ecosystems (Table A5.1).

TABLE A5.1. EIGHT TARGET OUTCOMES UNDER PORTFOLIO (2).

CODE	TARGET OUTCOME	ANNUAL FUNDING (NZ$)
TO1	Define New Zealand's biota	$6–9 million
TO2	Reverse the decline in New Zealand's biota	$7 million
TO3	Biosecurity—incursion management	$2.5 million
TO4	Biosecurity—management of existing pests	$4 million
TO5	Protection of the unique ecosystems of the Southern Ocean and Antarctica	$0.25 million
TO6	Sustainable use of aquatic and terrestrial biota	$5 million
SPS	Sustainable systems for production, use and harvest in aquatic systems	$2 million
SRU	Effective biosecurity systems across sectors	$2 million

FRST called for research proposals to address priority issues relating to biodiversity and other topics. Two of Landcare Research's proposals that were accepted as OBIs relate directly to DOC's management of terrestrial ecosystems. They are:

- Ecosystem resilience, addressing Target Outcomes 2 and 4
- Sustaining and restoring biodiversity, addressing Target Outcome 2

Both OBIs have Intermediate Outcomes that contribute to the achievement of the Target Outcomes.

Ecosystem resilience has five Intermediate Outcomes:

- Reducing threats to forest ecosystem processes (protection against introduced herbivores)
- Reducing threats to forest ecosystem processes (prioritising pest species for control)
- Increasing natural ecosystem resilience to weeds
- Biodiversity response to global change
- National Vegetation Survey Databank

Sustaining and restoring biodiversity also has five Intermediate Outcomes:

- Reducing extinction risk by sustaining genetic diversity
- Sustaining critical functional species interactions
- Increasing effectiveness of conservation flagships
- Maintaining threatened rare ecosystems
- Restoring dryland biodiversity through woody dominance

DOC has been involved in the OBI process by providing:

- Accountability for provision of resources
- Accountability for implementation (uptake) of OBI products
- Accountability for OBI governance

This involvement has resulted in significant success in funding and establishing the direction of research.

Appendix 6

RECENT DOC REPORTS ON FIRE MANAGEMENT

This appendix summarises seven key documents on fire management completed for or by DOC. They are:

- The use of fire for conservation management in New Zealand (Allen et. al 1996)
- Fire ecology and control research plan 1997/2006 (Hilliard & Timmins 1998)
- Fire ecology and management information transfer from Western Australia to New Zealand (Burrows 1999)
- Brief statement on strategic priorities for research 1999 (Timmins et al. 1999)
- Report on the fire management systems audit (DOC 2005b)
- General policy for national parks (NZCA 2005) and Conservation General Policy (DOC 2005a)
- Long-term approach to fire management (Hilliard et. al 2005)

A6.1 The use of fire for conservation management in New Zealand

Landcare Research provided DOC with a summary of previous scientific reviews of fire ecology in New Zealand. It reviewed international and New Zealand literature on the use of fire for managing grasslands, shrublands and wetlands for conservation purposes. Techniques for monitoring fire impacts on ecosystem recovery and recommendations for use of fire in ecological management were also prepared.

Landcare Research suggested that prescribed fire be used to meet management objectives in New Zealand's protected natural areas. However, knowledge of the effects of fire on many ecosystem components is scarce or lacking. Caution was advised in the planning and application of fire as a management tool (Allen et al. 1996).

A6.2 Fire ecology and control research plan 1997/2006

This internal DOC document provides a list of the fire research topics that require attention in the next 10 years, ranking the following highly in terms of urgency and importance:

- The impact of fire on native communities and species
- Fire behaviour
- Fire as a management tool
- Fire control
- Monitoring and information transfer

However, this document was not formally accepted by DOC and no recommended actions have been undertaken.

A6.3 Fire ecology and management information transfer from western Australia to New Zealand

This is the most recent formal summary of DOC's approach to fire ecology and management information. The document contrasted aspects of western Australian fire management with New Zealand fire ecology. This work identified various principles. It also recommended establishing a national Wildfire Threat Analysis, incorporating this into each level of land management planning and broadening it to include fire ecology. For example, Conservation Management Strategies (CMSs) detail fire management and strategies for special areas.

The document contained a warning that:

> 'The Department's reluctance to use fire as a management tool in relation to conservation of flammable vegetation types, and political and agency disagreement over the primary objective and best course of action or confusion about fire management could lead to a major fire crisis, causing damage to property and conservation values and possibly loss of human life.' (Burrows 1999: 26)

This would be alleviated by:

> 'Recognition and definition of fire issues, the formulation of clear fire management policies and objectives underpinned by sound science, and a well trained and well equipped fire fighting force will reduce the risk and impact of a major fire.' (Burrows 1999: 26)

A6.4 Brief statement on strategic priorities for research: fire ecology and control

Timmins et al. (1999) developed eight strategic priorities for fire research for DOC. These were:

1. Comprehensive research programme on fire ecology and ecosystems
2. Study of the effect of fire on different native communities
3. Investigation of the long-term impacts of fire on ecosystems
4. Development of a fire behaviour prediction system for a range of fuels
5. Risk assessment of fire to indigenous species and safer working conditions for firefighters
6. Investigation of the behaviour of fire regimes under different climatic regimes
7. Study of the effect of prescribed fire on indigenous species
8. Investigation of the synergy of fire with other management practices to maximise biodiversity

The eight priorities were not acted upon by DOC.

A6.5 Report on the fire management systems audit, March 2005

The internal audit provides the background to issues facing fire managers in DOC, and suggestions for a way forward. It does this by:

- Helping to clarify DOC's strategic direction for fire management
- Providing a basis for a response to the Department of Internal Affairs' review
- Identifying the issues and making recommendations for improvement to support DOC's desired national and regional direction

The audit team advocated for DOC to make the most of opportunities to substantially change the way it manages fire by:

- Being much clearer on its strategic direction for fire management
- Clarifying roles and creating a consistent national approach
- Rethinking how DOC is involved in New Zealand's overall fire management

The team also recommended that a fire research needs analysis be undertaken (in Appendix 2 of the report).

A6.6 General policy for national parks and Conservation General Policy

These government policy documents guide, and in some cases direct, Ministerial decisions. They will similarly guide and direct decisions of the Director-General of DOC and other decision makers under the legislation. In particular, they will shape a new round of CMSs and Conservation Management Plans over the next few years, as well as revised national park plans. The scope of the policies are broad, reflecting the wide spectrum of conservation areas administered under the legislation and the many conservation tasks to be performed. Relevant text from the Conservation General Policy is below:

> *4.3 Fire management*
>
> *4.3 (a) Conservation management strategies and plans should make provision for fire management, covering fire risk, fire protection, fire control, fire regimes, and the use of prescribed burning for ecosystem management.*
>
> *4.3 (b) Conservation management strategies and plans may provide for small-scale prescribed burning where it is clearly necessary to:*
>
> *i. manage fuel loadings where this addresses a significant risk and is ecologically justified; or*
>
> *ii. preserve specified indigenous species, habitats or ecosystems.*
>
> *4.3 (c) Fires may be allowed to burn where the Principal Rural Fire Officer considers that the risks to people, places and property can be managed in accordance with predetermined fire plans, which should take into account planned conservation outcomes.*
>
> (DOC 2005a: 24)

4.7 Fire management

4.7(a) A national park management plan may provide for prescribed burning where necessary to:

i) manage fuel loadings where this addresses a significant risk and is ecologically justified; or

ii) preserve specified indigenous species, habitats and ecosystems.

4.7(b) Fires may be allowed to burn where the Principal Rural Fire Officer considers the risks to people, places and property to be manageable in accordance with predetermined fire plans that should take into account national park values. (NZCA 2005: 27)

A6.7 Long-term approach to fire management by DOC

This is an unpublished, internal DOC report presented to the General Manager of RD&I, 21 July 2004.

The paper describes the context of the legislative fire management changes and discusses how DOC needs to be able to anticipate and account for these changes. DOC must also be able to implement new ways of managing fire supported by sufficient and robust information.

It identified that DOC needs to be proactive in formulating long-term fire management policies and approaches. It went on to say that DOC is at risk of having to attend increasing numbers of fires owing to changes in land tenure, acquisition of land (particularly grasslands), changes in land use and increased recreational use. Currently there is also a review of the national structure of fire-fighting authorities, including rural areas, and fire funding.

The document identifies some changes, opportunities and risks relating to DOC's fire management. It recommends that DOC invests in developing a long-term strategy (10–20 years) for fire management that includes and addresses the following:

- Build on, support, initiate and contribute to fire research projects.
- Develop specific fire management plans for high-risk or important conservation areas. Reflect and include this in conservancies' CMSs.
- Become more proactive in monitoring recovery after fires, undertaking restoration of significant sites, and learning more about fire ecology.
- Develop decision support tools for line managers to use when assessing whether fires should be left to burn or suppression activities undertaken.
- Use fire as a management tool to sustain desirable habitat types for specific biodiversity or recreational values.

Appendix 7

DECISION SUPPORT SYSTEMS FOR OPERATIONAL MANAGERS

An essential part of DOC's ability to manage fire and to direct associated research is the development of a decision support system for operational line managers. This will help managers assess the key question of whether fires should be left to burn or actively suppressed.

A decision support system is a computer-based decision support tool including a spatial display of the fire environment factors, as well as the social and ecological values of importance to DOC. The system can draw heavily on:

- Existing knowledge of fire behaviour
- Wildfire threat analyses (see Fig. A7.1)
- Detailed research and mapping of ecosystems and the social environment

In the wildfire threat analysis diagram below (Fig. A7.1), ignition potential is described as RISK, potential fire behaviour is described as HAZARD, and values threatened are described as VALUES. The results of a Wildfire Threat Analysis can have multiple uses for a Rural Fire Authority's management activities—including fire prevention, fire mitigation and resource allocation. It can also be used to establish benchmarks to determine appropriate fire control measures.

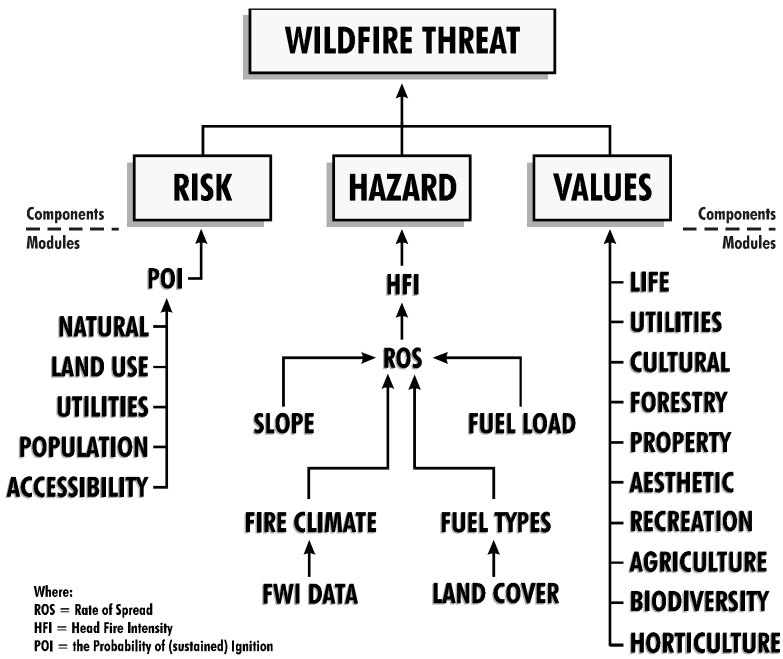


Figure A7.1. Wildfire threat analysis diagram. From NRFA (2005b). Note: FWI is the 'Fire Weather Index'.

Appendix 8

INTERVIEWEES' RESPONSES RE: DOC'S CURRENT AND FUTURE RESEARCH NEEDS

The 80 people interviewed as part of this project identified the research needs presented below. Their feedback is in two parts:

- General research, non-specific to fire, that they believe will usefully support DOC's fire management
- Specific fire-related research

This information led to the 64 specific actions identified in Section 4.1.

A8.1 General research

The general, non-fire-specific research that respondents said would provide useful technical information to support DOC's role and responsibilities for fire management needs to:

1. Align DOC fire research with the purpose of the Forest and Rural Fires Act 1977 for the 'safeguarding of life and property' in DOC's fire jurisdiction.
2. Manage fire research and organisational links within DOC through the establishment of one new position, a 'Senior Technical Support Officer (Fire)'.
3. Undertake research to support the recent Conservation General Policy on fire management.
4. Ensure technical transfer of information from 'researchers to department managers' and 'researchers to researchers', which is key to increasing understanding and awareness of fire management.
5. Continue supporting the current Forest and Rural Fire Research Programme and seek completion of outstanding projects.
6. Undertake and support additional research outcomes from experimental burns (e.g. invertebrate studies).
7. Establish a decision support system to assist managers deciding on whether to actively suppress a fire or manage it for 'safeguarding of life and property' only.
8. Complete a national wildfire threat analysis for all lands administered by DOC in collaboration with all Rural Fire Authorities.
9. Model fuel types, fuel loadings and fire behaviour for:
   a) Achievement reporting to estimate 'what difference was made by the actions taken'. A national wildfire threat analysis is required for this.
   b) Enhancing fire suppression tactics and safety of staff.
10. Prioritise fire management for conservation of biodiversity and appreciation assets.

11. Establish a clear management philosophy and hierarchy of landscape, ecosystem and site management. This needs to come from DOC's 'Sites group'

12. Pre-emptively manage fire to minimise future losses. There are two key actions required by DOC in order to undertake this effectively: gaining social acceptance for the use of fire as a management tool; and clearly defining ecosystem management policy and practice.

13. Develop social research to improve relations with rural communities and the wider public.

14. Convene, manage and fund a national workshop on fire management and the place of fire ecology in New Zealand.

A8.2 Research specific to fire

The following list identifies the technical information respondents believe that DOC needs to manage fire.

1. Policy and planning

1.1 Investigate the benefits of DOC's carbon credits accumulating through current land management. Identify potential loss of carbon credits by fire in a range of ecosystems and the impacts of these.

1.2 Identify a national approach to managing specific sites across the New Zealand landscape. Incorporate this into the review of the Conservation Management Strategy (CMS) process.

2. Decision support systems

2.1 Develop a decision support system and train managers in its use.

3. Wildfire threat analysis

3.1 Complete and validate a national wildfire threat analysis for DOC in collaboration with all Rural Fire Authorities.

4. Social

4.1 Encourage social research on fire and fire ecology within DOC and other agencies. Emphasis needs to go on dryland ecosystems.

4.2 Promote the importance of public awareness of the threat of fire to features of importance to them and DOC (e.g. people living in the rural–urban interface; Medbury Scientific Reserve; disposal of ashes around huts).

5. Ecological

5.1 Study disturbance regimes and identify the role of fire in them.

5.2 Identify appropriate techniques to minimise the impacts of pest plants after fire.

5.3 Identify inventory and monitoring techniques that apply to sites that have been burnt.

5.4 Study recovery rates of ecosystems after fire and identify techniques to rehabilitate ecosystems post-fire.

5.5 Identify ecosystems and species that could benefit from prescribed fires to maintain them.

5.6 Model ecosystem recovery using data from historic burns and current research.

5.7 Acquire information on changes in invertebrates after fire.

5.8 Establish and apply guidelines on management of tussock grasslands, especially lands under DOC jurisdiction as a result of the Land Tenure Review process. The role of fire must be included in this.

6. Climate change

6.1 Study the changes in fire behaviour under climate change scenarios.

7. Fire behaviour

7.1 Build geospatial fuel models. More experimental burns are required to increase the knowledge of fire behaviour and assist in monitoring the effects of ecosystems post-fire.

7.2 Undertake experimental burns on conservation lands for credibility and continuity of management, especially ecosystem monitoring.

7.3 Map and monitor fuel types, fuel loading, fire climate and potential fire behaviour for a range of conditions.

7.4 Establish and apply prescribed burning guidelines.

8. Techniques

8.1 Improve the information on retardants, especially those applied in or near wetlands and streams. Also investigate the use of salt water as a retardant.

9. Management

9.1 Establish a Senior Technical Support Officer (Fire) to undertake technical transfer from researchers (inside and outside DOC) to DOC managers, coordinate research and oversee the development and implementation of strategic planning, and implementation of the strategies.

9.2 Employ, train and retain staff with fire management experience in DOC.

9.3 Integrate fire management within DOC's organisational structure.

9.4 Establish a Technical Advisory Group (TAG) for fire management decisions, to include both social and ecosystems specialists.

9.5 Collect information on fire ecology for Natural Heritage Management System (NHMS) reporting, for fire management and for a research database.

10. Technical transfer

10.1 Transfer of fire research management techniques to DOC staff as required.

10.2 Prepare technical papers and conduct workshops on fire research and management findings.

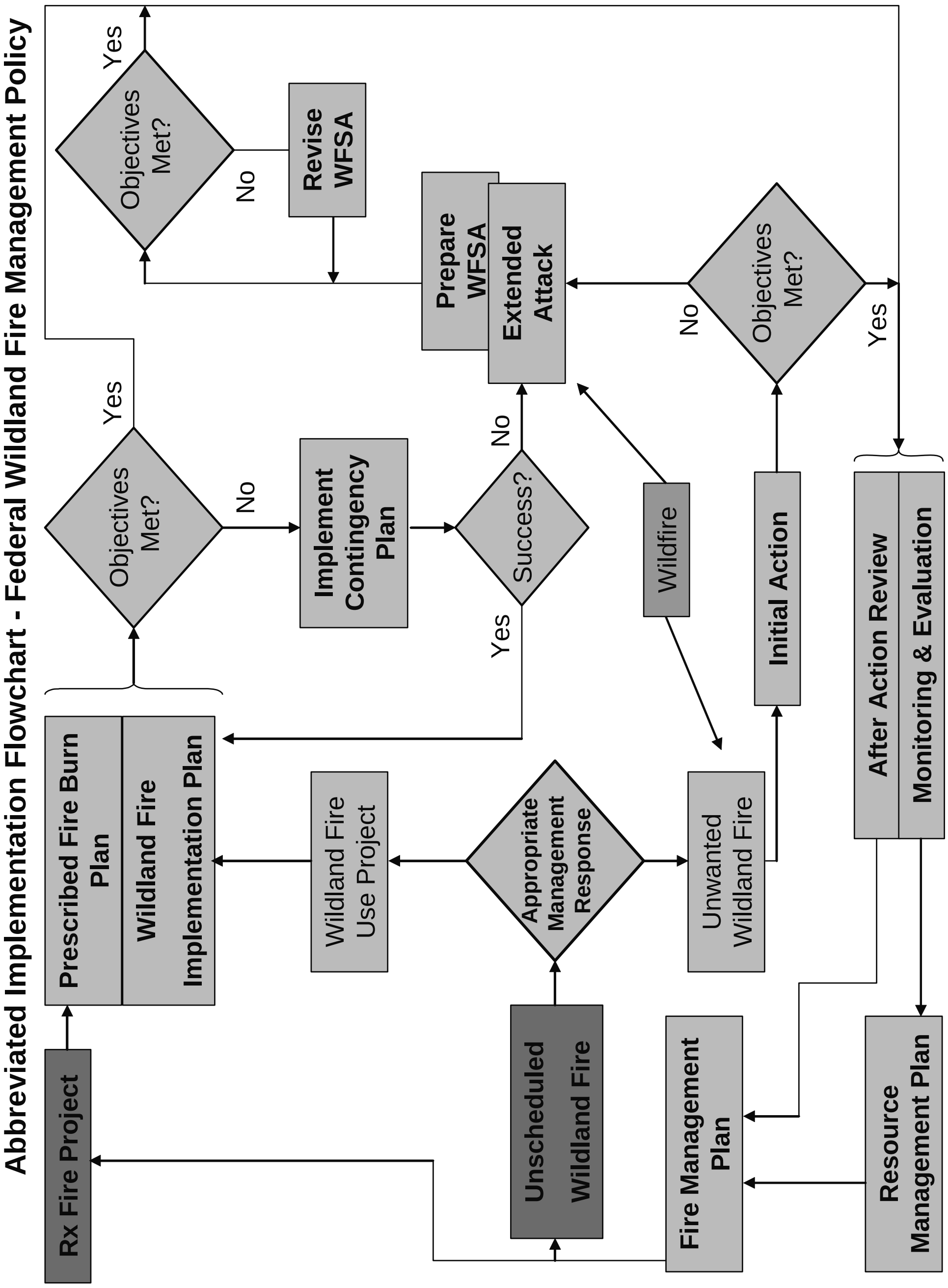
10.3 Undertake a literature review of fire research and management in New Zealand.

10.4 Run a biennial fire management workshop to include staff of DOC and other relevant agencies.

Appendix 9

US FEDERAL FIRE POLICY

Taken from National Fire & Aviation Executive Board, Policy Directives Task Group (2004).



Appendix 10

ENSIS RURAL FIRE CONTROL: FIRE BEHAVIOUR AND RISK MANAGEMENT

<table>
<tr><td colspan="4">Department of Conservation
Te Papa Atawhai</td><td colspan="3">***Investigation Summary: 200/06***</td></tr>
<tr><td rowspan="2">**Investigation Number**</td><td rowspan="2">**34851**</td><td rowspan="2">**Key Output**</td><td rowspan="2"></td><td colspan="2">**Agreed Completion Date**</td><td>30 June 2010</td></tr>
<tr><td colspan="2">**Reporting Date**</td><td>March 2006</td></tr>
<tr><td>**Title**</td><td colspan="6">Rural Fire Control: Fire behaviour and risk management</td></tr>
<tr><td>**Agency**</td><td colspan="3">**Ensis**</td><td>**Investigation Leader**</td><td colspan="2">**Grant Pearce**</td></tr>
</table>

Objectives

Every year, significant areas of New Zealand either experience or are threatened by wildfire, and the reality is that the risks from rural fire are growing. This programme aims to protect life, property, and economic and conservation resources from wildfire in New Zealand's rural environments. This goal will be achieved through providing land managers, Rural Fire Authorities (RFAs) and policy makers with information and tools that will help reduce the number and consequences of wildfires.

The research programme aims to improve understanding of fire behaviour in the New Zealand fire environment by developing a New Zealand Fire Danger Rating System (NZFDRS) to support fire management decision making. Key components of the NZFDRS include a New Zealand Fire Behaviour Prediction (FBP) System comprising models that predict fire behaviour in different vegetation types, and models describing the effectiveness of various firefighting resources in relation to fire behaviour and other fire environment factors (e.g. vegetation and terrain). Increasing our knowledge of the role of fire in the sustainable management of New Zealand ecosystems is also a high priority, and the second major objective, research to quantify the effects of fire on tussock grasslands, provides a case study on the role of fire in ecosystem management so that appropriate management can be developed.

Outputs achieved

A pilot study of fire danger communication, conducted via a University of Canterbury Social Science Research Centre summer studentship, has been completed. Interviews were conducted with fire managers from the Canterbury region to determine the messages being portrayed through fire danger signs and other methods. Results were presented to the Canterbury–West Coast Regional Rural Fire Committee, and a report on the findings is being edited prior to publication. Extension of the pilot study to other parts of the country is currently being planned.

An analysis of the effects of the Interdecadal Pacific Oscillation (IPO) was completed as part of the first stage of a broader project on the impact of climate variability on seasonal fire danger. The fire climatology database containing weather and fire danger records was also updated. The second stage of the analysis, investigating the effects of El Niño-Southern Oscillation (ENSO) events is presently underway.

The Fire Research team hosted the NZ Fire Service Commission in Christchurch on 21 and 22 February 2006, and presented an outline of research activities, the Ensis Bushfire Research Group and Bushfire Cooperative Research Centre involvement. Commission members also visited the Torlesse research burn site, and were given an overview of the fire behaviour research being conducted.

Appendix 11

AGRESEARCH INVERTEBRATE STUDY IN OTAGO

Department of Conservation *Te Papa Atawhai*				***Interim Investigation Summary: 2003/04***	
Investigation Number	**3667**	**Key Output**		**Agreed Completion Date**	31 Dec 2008
				Reporting Date	21 Jun 2005
Title	Tussock grassland invertebrate community structure and function, and impact of habitat disturbance by fire				
Agency	**AgResearch**			**Investigation Leader**	**Dr Barbara Barratt**
Investigation Collaborators	Marcus Simons, Otago Conservancy: support by coordinating maintenance of field sites, fencing and weather stations, and any other local operational assistance as required Greg Sherley, DOC Central Regional Office, Wellington: science review and liaison Ian Payton, Landcare Research, Lincoln: overall Fire Ecology project leader Kath Dickinson, Ecology Research Group, Otago University: research collaborator Colin Ferguson, AgResearch Invermay Nigel Bell, AgResearch Ruakura: research collaborator* Upali Sarathchandra, AgResearch Ruakura: research collaborator* Trevor Jackson, AgResearch Lincoln: research collaborator* * researchers in FRST programme				

Investigation overview

Invertebrate biodiversity in tussock grasslands is poorly understood, although studies have indicated that the fauna is diverse with a high degree of endemism. DOC is responsible for the management of significant areas of native grassland and this area is increasing as a result of the Land Tenure Review process. In order to maintain conservation values of these areas, an improved understanding of the biodiversity and dynamics of grassland ecosystems is required. Fire is an important threat to dry eastern grasslands and a major disturbance mechanism, but it also has potential to be used as a management tool. The joint Fire Ecology project initiated in 1998 by DOC, Landcare Research and the Forest Research Institute (now Ensis) has laid the foundations for a comprehensive and unprecedented tussock grassland community ecology study.

Trial sites have been established at Deep Stream and Mt Benger in Otago, representing an eastern Otago lower altitude tussock grassland and a Central Otago higher altitude grassland, respectively. A major objective of the project is to provide DOC with information that will assist in the future management of natural grassland ecosystems. AgResearch will continue to contribute to knowledge of invertebrate biodiversity, and an understanding of the impacts of fire on the invertebrate fauna, and process of community recovery. In conjunction with FRST-funded work, the investigation includes studies of the composition, abundance, species diversity and trophic structure of the invertebrate fauna; short- to longer-term impacts of tussock burning on invertebrate communities; the comparative impact of managed burns in moist spring conditions compared with accidental fire in hot dry summer conditions; and characteristics of recovery of the fauna.

Results

At both sites it is clear that total invertebrate densities vary considerably between years (Table A11.1), but that both the spring and summer burns were associated with significant reductions in invertebrate densities in 2001/02. In 2003, Thysanoptera numbers were so high that overall invertebrate numbers appear to have returned to or in some cases exceeded pre-burn levels. In fact many groups remained significantly adversely affected by the fires. In 2004, invertebrate densities in the control plots were quite similar to those of the previous 2 years. Densities in the spring and summer burnt plots were generally higher, especially in the tussock samples where total invertebrate densities were up to three times higher than in the control plots.

This could be attributed to Thysanoptera and Pseudococcidae densities, which remained relatively high, and a few other groups where population responses were positive. Of particular interest, Crickets (Gryllidae), which had been recorded only at very low densities at Deep Stream, appeared in burnt plot samples at densities of up to 69/m^2 in 2004. Many of the litter and organic detritus feeding groups remained at densities below those of the control plots. These included Amphipoda, Isopoda, Diplopoda, Symphyla and Protura.

TABLE A11.1. MEAN (± SEM) DENSITY (NUMBER/m^2) OF TOTAL INVERTEBRATES FROM 1993–2003 AT DEEP STREAM AND MT BENGER SITES (BOLD ITALICISED AREAS ARE POST-BURN).

	CONTROL PLOTS		SPRING BURN PLOTS		SUMMER BURN PLOTS	
	INTER-TUSSOCK	TUSSOCK	INTER-TUSSOCK	TUSSOCK	INTER-TUSSOCK	TUSSOCK
Deep Stream						
January 1999	7564 (1693)	1866 (529)	6135 (763)	2291 (613)	7748 (1634)	936 (287)
January 2000	3683 (320)	2115 (574)	6617 (996)	2081 (546)	6286 (1418)	1791 (336)
January 2001	3652 (393)	2314 (98)	7429 (2134)	4216 (1771)	5161 (1361)	2135 (531)
March 2001	2345 (549)	2562 (430)	–	–	***320 (85)***	***495 (231)***
January 2002	4098 (499)	3224 (1340)	***1161 (326)***	***1089 (191)***	***534 (27)***	***707 (151)***
January 2003	4063 (1041)	2781 (514)	***2218 (346)***	***2181 (453)***	***5762 (738)***	***6592 (763)***
January 2004	4533 (168)	3608 (220)	***6294 (463)***	***9841 (2229)***	***6181 (291)***	***10410 (140)***
Mt Benger						
January 1999	1064 (168)	4325 (1187)	1372 (405)	3903 (709)	1939 (486)	4848 (2453)
January 2000	2801 (254)	1713 (404)	1981 (382)	2055 (320)	2452 (704)	3040 (1317)
January 2001	1619 (94)	2061 (307)	***775 (402)***	***2022 (488)***	–	–
January 2002	3329 (925)	1584 (1042)	***361 (140)***	***1226 (410)***	1974 (36)	2794 (308)
January 2003	3085 (787)	2397 (375)	***3413 (452)***	***5533 (1194)***	–	–
January 2004	2605 (549)	3999 (534)	***2321 (523)***	***3625 (600)***	–	–

At Mt Benger, data from the 2004 sampling show no significant differences in total invertebrate density between burnt and un-burnt treatments (Table A11.1). However, as for Deep Stream, this is masked by differences between taxonomic groups. Taxa that were significantly reduced in density immediately post-burn and that appear not to have recovered are Amphipoda, Opiliones, Pseudoscorpionida (low density in control plots but so far absent from burnt plots), Diplopoda, Blattidae, Formicidae, and some families of Coleoptera. Those that have responded positively post-burn, such as Aphidae, have returned to pre-burn densities, but the Chrysomelidae and particularly the Thysanoptera (which in 2003 increased dramatically in numbers in response to the fires) have remained high in 2004. These herbivorous insects have probably responded to the flush of new growth following the fire.

Conclusions

The data are clearly demonstrating that the invertebrate density (excluding Collembola and mites) in tussock grassland at these two sites fluctuates naturally. At Deep Stream, inter-tussock and tussock densities averaged about 4500 ± 607 (SEM) and 2600 ± 275, respectively (control plots) over the 6 years of January measurements. At Mt Benger, inter-tussock and tussock densities were more similar, averaging about 2400 ± 362 and 2700 ± 485 (control plots) over the 6 years of January measurements. If microarthropods (Collembola and mites) are included, these figures increase by a factor of about 8–10 (Barratt, pers. comm. 2005). The sampling is now well into the period of measuring indirect impacts of burning rather than direct impacts of the fire on the particular groups. Hence the researchers assert that they are measuring effects on invertebrates that have been brought about by changes in litter availability, plant growth responses and plant species composition changes. Some very interesting community and population dynamics are starting to emerge, with some invertebrate groups responding very positively to the post-burn environment, and others still showing no sign of recovery to pre-burn densities.

New Zealand Government