CONTROLLED BURNING TO FORM A GREEN-BELT FIREBREAK THROUGH KAINGAROA FOREST

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SYNOPSIS

On an area of almost 1,800 acres surrounded by forest a net area of 1,500 acres was safely burnt. Factors assisting this achievement were:

adequate firebreak preparation around the area to be burnt;
subdividing the area into manageable burning blocks;
a study of weather conditions and special forecasts;
a planned burning technique and method of operation;
suitable and sufficient men and equipment;
painstaking elimination of dangerous hot spots after burning.

INTRODUCTION

The decision to grass a half-mile strip across Kaingaroa Forest to form a firebreak was made in 1956. It brought with it, however, the problem of converting land, much of which was already growing a forest crop, into pasture.

The area was burned to prepare it for grassing, timber being logged from the older stands beforehand. Evidence that this was a sound proposal already existed near Tokoroa where comparable conversions had been made successfully.

History

The gross area of Kaingaroa Forest is 335,000 acres of which 248,000 acres have been planted. The planted area is divided into compartments separated by so-called firebreaks. This is a misnomer for what are in fact management boundaries. The planted area is virtually an unbroken expanse of forest or other flammable ground cover.

The best fire prevention organisations cannot completely exclude the risk of fire. To reduce the extent of forest that could be swept before a fire was checked, it was decided to have grassland firebreaks at selected points and the first such strip has now been completed.

Firebreak Management

An area of land of 1,800 acres would be an expensive firebreak if it were unproductive. It would likewise be a poor firebreak if the grass growth became rank and weeds prospered. The remedy in both cases is to farm the land. This has been arranged with the Department

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of Lands and Survey who will farm the land, the tenure of which will remain with the Forest Service.

Location of the First Firebreak

About one-third of the way down its length, Kaingaroa Forest narrows appreciably and is partially broken by farmland intruding from the west. This was a logical place to form a firebreak. A larger area of forest would have to be converted to grass in the wider parts of the forest immediately to the north and south.

The land to be sown in grass was predominantly flat to gently undulating, but included several hillocks with steep slopes. The Wheao River runs past the eastern end of the strip and the Rangitaiki River through the middle.

In the chosen location farming is facilitated by the firebreak being contiguous to existing farmland.

Ground Cover

The total area to be cleared was 1,800 acres. This was divided almost equally into land growing forest, and land growing manuka interspersed with islands of small radiata pine.

Radiata pine planted in 1928 formed the forest. Much of this was poor stands growing on low quality sites. All the stands were logged before burning, usually by tractor and logging arch, although some areas were hauled with a Skagit high-lead mobile hauler. The stands yielded between 7,500 and 8,000 cubic feet to an acre. Logging continued over a period of 21 months. The length of time the slash had been on the ground determined the success with which it could be burnt. This will be described later.

The scrub land was mostly covered with manuka, with manoao and tussock in the lower lying areas. This entire area had been drill sown with radiata pine in 1948 and pockets of trees from this operation were growing amongst the manuka. This part of the firebreak was prepared for burning by crushing with a D7 tractor. The blade of the tractor was used to knock down the trees and a log was towed over the manuka.

The danger of debris matting around a hot motor was appreciated and the bulldozer was hosed down with wáter regularly. In spite of this the debris and motor once caught fire, emphasizing the risk accompanying this work.

The Forest surrounding the Burn

The area felled and over which logging slash had to be burnt was adjoined on both sides by pure stands of radiata pine planted in 1928. The crushed area had Corsican pine, planted in 1929, to the north and radiata pine, planted in 1929, to the south.

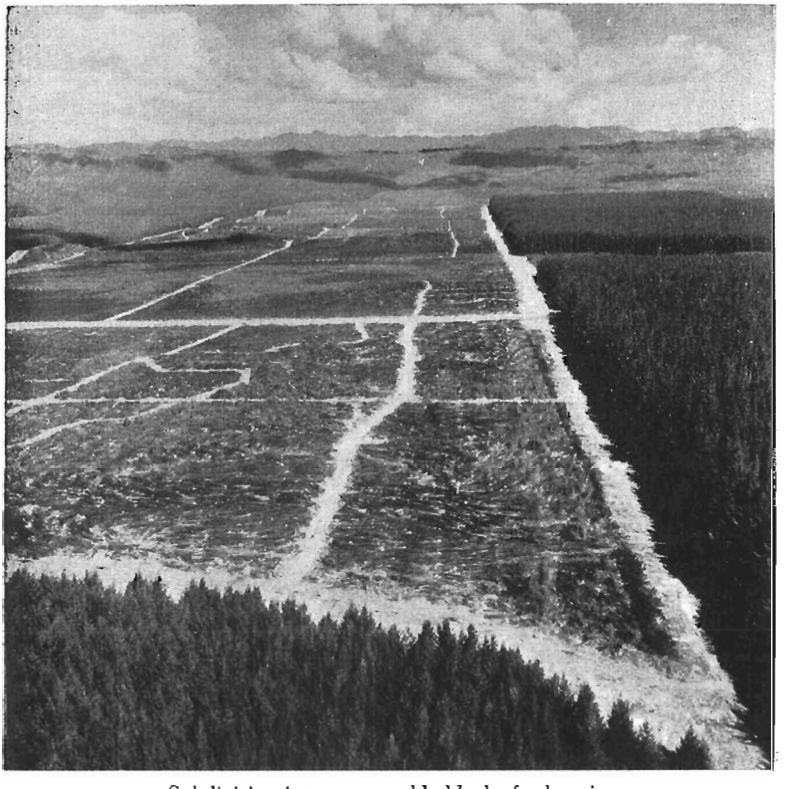
Protection whilst Burning

A cleared strip between one chain and one and a half chains wide

was formed around the perimeter of the burn. This was suitable for vehicles to use.

For burning control the land was subdivided into blocks, each of which was under 50 acres. Some, especially near the edges and close to the forest, were much smaller. In the logged areas, where bulldozing was difficult, use was made of logging roads and extraction tracks, cleared and widened when necessary. Where these were not available new tracks were made. In the crushed area blocks were formed by a bulldozer clearing scrub to form strips of bare earth.

Long-range weather forecasts were obtained from the meteorological office in Wellington whenever burning was contemplated. All weather factors were examined but particular stress was placed upon wind. Burning was postponed if strong winds were expected to develop, whatever their direction. Nevertheless some wind is essential for controlled burning as without it there can be no pattern of burning and fire is at the whim of every irregular eddy.



Subdivision into manageable blocks for burning

Organization, Manpower, Equipment and Communications

W. Girling-Butcher* planned the entire burning operation and controlled it throughout. He first prepared a written plan outlining procedure, individual responsibilities, resources to be used, and also the resources available in an emergency. This information was promulgated to all persons concerned with the burning.

The manpower and equipment needed on any particular day varied, but it was usual to have about fifty men and a variety of hand tools. The men were supported by earth-moving machines and fire tankers. Pumps stationed at the Rangitaika and Wheao Rivers provided a close and abundant supply of water.

Radio-telephones were used to co-ordinate activities at the fire and to provide communications with forest headquarters.

METHOD OF BURNING

All lighting was done with knapsack flamethrowers burning diesel. Men on this worked in pairs for safety. Men and fire tankers patrolled the edges continuously during burning and an aerial patrol was on call if needed.

Logging Slash: Slash was first pushed back into the logged area by a bulldozer with a root rake, for a distance of five chains from the margins. The method of lighting was to fire the lee side first, letting this burn back. This was steadily widened by working back into the wind with successive and parallel strip lighting. The width of strip allowed to burn with the wind was varied according to density of fuel, flammability, speed of fire spread, wind and other weather influences, and the proximity to standing forest.

In the early stages of getting the fire safely back from the dangerous edge the factor that limited the width of strips lit was the danger presented to the adjoining forest by the resultant body of fire. Other factors were all interpreted in relation to the influence they would have on this.

Once the fire had burnt back a safe distance from the edge the emphasis changed. A fire burning with the wind was no longer a danger as it was beating on to land already burnt. The width of strips lit at this stage was determined by the uniformity of fuel and rate of fire spread. Broken irregular fuel that would not support a continuous line of fire for any distance necessitated that strips be kept close to ensure a clean and complete burn. When the fuel was continuous the strips were widened. If the fire spread was slow it was quicker to light additional strips than wait for one line of fire to travel a longer distance. Again, if the fire was spreading quickly the strips were widened.

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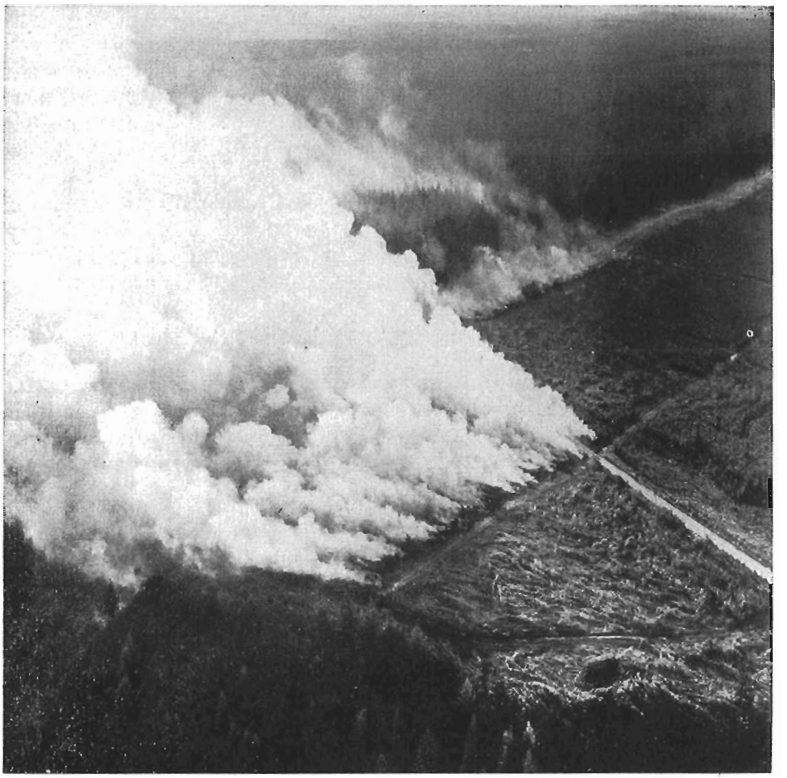


The pattern of burning. One marginal block is being completed and lighting has started along the lee side of the next block beyond.

At all times the flanks were lit ahead of the existing line of fire. The area so burnt safeguarded either side in the event of a wind change during the time the next strip was burning.

Crushed areas: It was easier to bulldoze firebreaks in the crushed area than amongst the stumps of logged stands. This made it practicable to cut off a five-chain belt down both sides, where burning adjoined the forest. The blocks comprising this were burnt out first to give an added margin of safety. They were lit by burning back in strips from the lee side. The radiant heat generated when burning such a marginal strip was sufficient on one occasion to scorch the side branches of adjoining radiata pine to a height of sixty feet. Subsequently, marginal trees were sprayed with water before the fuel alongside was lit, particularly if the fuel was abnormally heavy.

There was a variation in lighting procedure for the internal blocks in this part of the burn since the already burnt marginal strips

obviated the need to back-burn slowly. The fuel was usually even and continuous and fire spread rapidly. At the same time there was less heavy fuel than in the logging slash so that, besides burning out more quickly, the fires cooled more rapidly in the crushed blocks. All these facts favoured wider strips being lit in the crushed blocks than had been desirable in logging slash. Burning was still initiated on the lee side, followed by the flanks, but the next line of fire could now be lit as far as 10 or 15 chains further back. Because of the method of internal subdivision this sometimes coincided with a block boundary.

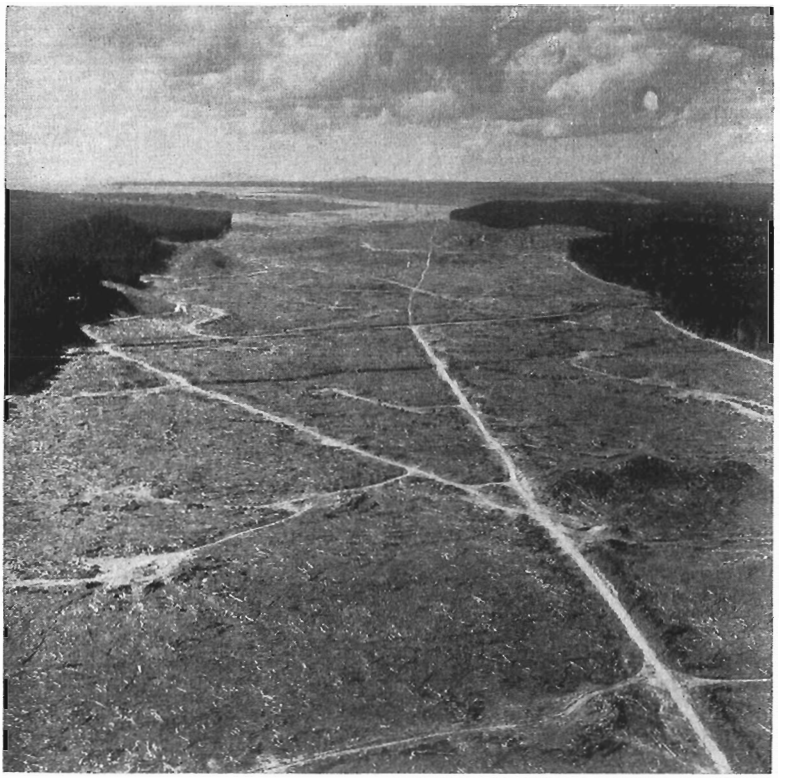
The sequence of firing, not only within blocks but henceforth also from block to block, continued to be from leeward to windward.

Time of Day: Lighting started in the afternoon and continued into the evening. The actual time varied according to the weather of the day. This meant that progressively safer conditions could be expected and gave time to make safe the smoulders in the heavy fuel. If lit in the morning, conditions progressively worsen and there is an abundance of smouldering material throughout the heat of the day.

Extinguishing the Fire. When burning on any section was completed fire extinction was begun, dangerous edges being worked first. Heaps of smouldering material were broken open, often with a bulldozer, before being dampened with water. "Wet water" was used as this gave better penetration of the hot beds of embers and ashes than ordinary water. This watering was followed by patrols on foot, working with hand tools and extending inwards from the edges.

EFFECTS OF BURNING

The crushed area, as might be expected, burnt cleanly and left little debris. The clean-up of logging slash varied. This was directly related to the length of time since logging. The volume of timber left is secondary to the time it has been down. When slash is two to three months old, depending upon the weather during this time, it is ready to burn. There is then a good supply of small dry twigs with needles still attached to kindle and carry fire. After being down a year logging slash becomes progressively harder to burn. The small twigs, which burnt so well earlier, become damp with decay and the needles fall. Grasses and weed growth appear and when it is dry enough for these to burn it is usually too dangerous to burn slash inside a forest. Grass and weed growth is therefore normally a hindrance to slash burning. Wherever the slash was over three months but under a year old it was easy to obtain a burn that consumed all small material. Scorched rounds of timber over four or five inches in diameter remained, with cleanly burnt-out ground between them. Slash over a year old took more stoking to get it to burn and it was difficult to establish a running fire. The result was a patch burn. To burn this cleaner would require drier, and therefore more dangerous, conditions than are needed for slash three to twelve months old.



The logged area after burning – all light material has been burnt, but heavy timber remains.

Correlating Weather and Burning Conditions

The object of any burning is to do it when the weather favours a clean burn and when there is little risk to surrounding countryside. This is vital when burning inside a forest. Under these circumstances, however, there is one distinction that can help and should not be overlooked. Open areas to be burnt dry out faster after rain than the shaded forest. Therefore, the safest time to burn is as soon after rain as the slash is dry enough. This important point may exert an overriding influence when considering the weather for burning on any particular day.

If the forest is still damp it is safer to burn with a lower humidity and stronger winds, compared with those normally acceptable, than it is to delay. In fact, under these conditions it is a mistaken sense of safety to postpone burning for several days, awaiting higher humidity

and lower winds. In the meantime the forest will have dried out considerably. This was considered carefully on all days on which burning was contemplated.

Local weather determines burning conditions and is easily observed. Cognisance must also be taken of the overall weather pattern as this will determine when changes can be expected. It will also determine whether conditions are likely to become safer or more dangerous. The N.Z. Meteorological Service co-operated in this respect by providing special forecasts, and these were studied before any burning took place.

To permit correlation of burning with weather conditions, a description of each day's burn has been appended, together with the meteorological data for the day. The figures are for Wairapukao, a permanent meteorological station which is three miles from the nearest area burnt and six miles from the most distant. The readings quoted are those for 9 a.m. and 1 p.m.

During burning, humidity readings were taken at the fire by the officer in charge of the operation. This was a safeguard only and the readings were not recorded. It was noticed at the time, however, that they were very close to the Wairapukao readings, usually being slightly lower. There were also moisture-content sticks on the fire-break. These were not read regularly but were always weighed prior to a burn. They also were close to the Wairapukao readings, again being slightly lower on all occasions. The Wairapukao figures appended will therefore give a good picture of the weather on the days of burning.

CONCLUSIONS

These are applicable to central North Island of New Zealand.

1. The pattern of burning should be to start on the lee side and progress into the wind.
2. Burning should not start before midday, and often much later, after the weather has passed the dangerous peak for the day. This ensures that conditions become safer as the burn progresses.
3. Radiata pine logging slash is best burnt between 3 months and 12 months after logging. Once it is older than 12 months it becomes difficult to burn and the temptation will be to burn when conditions are more dangerous to surrounding forest.
4. Burning within a forest is best done as soon after rain as the fuel is dry enough and while the forest surrounding the burn is still damp. This is preferable to timing a burn just before rain is expected. It may not arrive.
5. While wind is of major importance once burning is possible, neither wind nor any other influence is significant unless the fuel is dry enough to burn. As fuel moisture is the criterion that

determines when fire is possible it should be the subject first scrutinized. The significance attached to wind, temperature and humidity will vary according to the moisture content of the fuel, as this either limits or aggravates the influence exerted by other factors.

6. Long-range weather forecasts should be studied taking particular notice that there should be some wind but that major changes in direction are not predicted and that *no* strong winds are foreseen.
7. From this experience it may be stated that suitable weather for burning within a forest occurs 3 to 6 days after rain when, at 1 p.m. on the day of burning, readings occur within the following limits:

Fuel moisture	12 to 15	per cent of 100 gm. stick
Wind force	1 to 3	Beaufort rating
Temperature	55 to 70	°F.
Relative humidity	50 to 70	percent

8. It is worth stressing that this range of weather readings is a guide only; more extensive basic data could well cause it to be modified. Even with more experience anything along these lines should never be more than a guide. It would be dangerous to set down rigid limits as a variation in one factor could easily be compensated by an opposing variation in another. The condition of, and danger to, the surrounding forest must govern everything.
9. However, the paucity of similar information stresses the need for more extensive correlation between weather and fire behaviour in New Zealand. Information to enable this to be done should be collected by using portable meteorological instruments to take simple and basic observations at any large fire, whether it be a controlled burn or not. These readings could be correlated with notes on fuel type and fire behaviour.
10. A modest start such as this would yield information that would be of material help, not only when contemplating controlled burns but also when confronted with the need to suppress outbreaks of fire.

ACKNOWLEDGEMENTS

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All photographs were taken by Mr T. Ransfield, New Zealand Forest Service.

REFERENCES

GIRLING-BUTCHER, W. 1959, 1960. Operational plan to burn half-mile firebreak, Kaingaroa Forest. (Unpublished N.Z. Forest Service report.)

N.Z. FOREST SERVICE. 1960. Report of the Director of Forestry for the year ended 31 March 1960.

APPENDIX. TABULATION OF INSTRUMENT READINGS, WITH CORRELATED BURNING CONDITIONS

Date	Approx. acreage burnt	Time	Temp. °F.	Rel. Hum.	Wind Force (Beaufort)	Fuel Stick Readings 100 gm.	Fuel Stick Readings 400 gm.	Last Period of Rain Amount (inches)	Last Period of Rain Days previously
13 Oct. 1959		9 a.m.	49	73	1	20	27	1.93	6
	Nil	1 p.m.	54	64	1	16	22		
Poor burning conditions – heaps of slash burnt satisfactorily. Fire would not spread or travel. Impossible to endanger forest.									
3 Nov. 1959		9 a.m.	59	62	3	15	21	.94	3
	100	1 p.m.	67	53	3	13	20		
Reasonably easy to light burning. Fire spread readily without moving dangerously fast. Little chance of endangering forest.									
4 Nov. 1959		9 a.m.	63	69	1	15	22	.94	4
	150	1 p.m.	62	69	1	15	20		
Fires lit easily but required frequent strips to give a continuous burn. A slightly faster rate of spread would have been desirable without being dangerous. Little chance of endangering forest.									
17 Nov. 1959		9 a.m.	59	63	1	15	19	.48	6
	250	1 p.m.	67	66	2	13	17		
Good burning conditions – fires travelled readily – burnt fiercely in places. Fire could endanger forest but is unlikely to do so if kept small near edges.									
12 July 1960		9 a.m.	36	91	0	–	–	1.76	4
	Nil	1 p.m.	Winter timetable – no sticks out and no 1 p.m. readings taken. Much too wet even for patch burning heaps of slash.						
27 Oct. 1960		9 a.m.	56	82	1	18	18	.18	3
	350	1 p.m.	63	64	1	15	14		
Good burning conditions. Fire travelled well and burnt cleanly. Forest reasonably safe.									
23 Nov. 1960		9 a.m.	53	69	3	17	17	1.92	4
	350	1 p.m.	58	61	3	14	14		
Good burning conditions. Fire lit easily, spread well and burned cleanly. Forest wet and safe.									
28 Nov. 1960		9 a.m.	62	74	3	14	15	1.92	9
	300	1 p.m.	68	50	1	10	12	.03	1
Fires lit easily and burnt more fiercely with a faster spread than on any other occasion. There was a danger to surrounding forest. Careful burning is necessary under these conditions.									