Aerial suppression – need for evaluation

J.S. Gould[1,3], M.P. Plucinski[1,3], G.J. McCarthy[2,3]
[1] CSIRO Forestry and Forests Products, Canberra, ACT, Australia
[2] Forest Science Centre, Orbost, Victoria, Australia
[3] Bushfire Cooperative Research Centre, East Melbourne, Victoria, Australia

Corresponding Author: Jim Gould, Bushfire Behaviour and Management, CSIRO Forestry and Forest Products, Banks Street, Yarralumla ACT 2600 Australia (P.O. Box E4008, Kingston ACT 2604), telephone: 02 6281 8341, facsimile: 02 6281 8348, email: Jim.Gould@csiro.au

Abstract

In recent years, considerable attention has been given to aerial suppression programs as a result of rising cost, tight budgets and general interest by the public and media in the use of airtankers. Fire authorities have highlighted the extensive media coverage and strong community perceptions from the use of specialised aircraft for fire fighting. Aerial suppression provides an effective, immediate means of preventing future damage to properties, community assets and the environment from bushfires. With increasing public awareness and rising cost of aerial suppression there is a need for research dedicated to aerial fire fighting. The evaluation of aerial suppression resources, techniques and guidelines will deal with our inability to answer basic questions such as, *"How much aerial (retardant drops) and ground suppression is needed for a given fire suppression job?"* Fire control officers and incident control commanders have tried to answer such questions in general terms through experience. The answers, however, have not been quantitative, thus a co-operative operations evaluation of suppression tactics is necessary.

Introduction

Aircraft have been used operationally for active fire fighting in Australia since the late 1960s. The first trials using aircraft for aerial fire fighting were carried out in 1939 when brine solution was dropped from the air in cartons. Further trials were carried out in Victoria in 1947 using military aircraft to drop chemicals in metal tanks which were designed to burst on impact. Much progress has been made by the Australian bushfire control agencies in the intervening years and now the use of aircraft - both fixed wing and helicopters – for aerial suppression and other uses in combating bushfires is now commonplace with many fire organisations having integrated air operations. Today's aircraft fleet, comprising small and large agricultural aircraft and helicopters (with helibuckets/belly tanks), have found a useful place in Australian fire control. The role of aircraft continues to evolve in Australian bushfire operations as fire controller, fire managers and agencies seek the most efficient mix of resources to deal with the annual risk of bushfires.

In recent years, considerable attention has been given to aerial suppression programs as a result of rising cost, tight budgets and general interest by the public and media in the use of airtankers. Aerial suppression provides an effective, immediate means of preventing future damage to properties, community assets and the environment from bushfires. The fire control agencies have highlighted the extensive media coverage and strong community

perceptions from the use of specialised aircraft for combating bushfires. Media reports on the role of airtankers have given rise to unrealistic community and political expectations on the effectiveness of aerial operations and have resulted in the perception that aerial fire fighting is a "*glamorous and hi-tech*" way to fight bushfire. Not surprisingly aerial fire fighting is often perceived as the superior fire fighting tool. Unfortunately operations involving "*wonders*" of technology have not been examined in terms of their appropriateness; usefulness and effectiveness of aircraft are for fighting bushfires.

Over the past fifteen years there have been advances in evaluation of suppression technology including both ground and aerial suppression, equipment and the use of retardants. Most of these advances have occurred overseas, mainly in North America. North American research has focussed on water bombing drop patterns, primarily from fixed wing aircraft. In Australia the tendency is to mainly use helicopters for water bombing, particularly in populated areas. There has been little evaluation of aerial suppression done in Australia since the completion of Project Aquarius carried out by CSIRO in the 1980's (Loane and Gould 1986). Project Aquarius has been the largest cost-benefit study of aerial suppression undertaken in Australia. The number and type of aircraft used in fire suppression have changed considerably since Project Aquarius, as have operational costs.

The most recent Australian research into aerial suppression was carried out by McCarthy (2003) who surveyed experienced fire controllers and air operations staff concerning the effectiveness of aerial suppression during the 1997-98 fire season in Victoria. In Western Australia the Department of Conservation and Land Management and Fire and Emergency Services Authorities have conducted studies into the water bombing evaluating of agricultural aircraft in the Perth and southwest region of Western Australia the past five fire seasons. While operational surveys are a successful way of collecting qualitative data with minimal cost; although this data is subjective and prone to observer bias. Hence while surveys can provide substantial data their conclusions are not as strong as those from quantitative studies. This survey work should be continued over a range of fire seasons and expanded to cover more states. This would allow comparisons of seasons when resources are plentiful to those when they are stretched and also between practices and protocols used by the different state based fire fighting agencies. The role of aerial suppression should be examined in conjunction with ground suppression during fire fighting operations. The benefit that aircraft bring to support a ground crew needs to be considered and should be compared with aerial and ground suppression efforts alone.

Future research into the effectiveness of aerial and ground suppression resources, techniques and guidelines is required in order to answer the basic question, "*How much aerial (retardant drops) and ground suppression is needed for a given fire suppression job?*". Fire control officers and incident commanders have tried to answer this question in general terms through experience. The answers, however, have not been quantitative, thus an operational evaluation of suppression tactics is necessary so that a substantial dataset representative of aircraft and incident types can be collected. An evaluation of suppression should also achieve the following aims:

- Identification of the intensity of fires in different fuel types that can be contained by both ground and aerial suppression resources.
- Determination of rates of line construction for different suppression resources and combination of suppression resources
- Determination of holding time of suppression lines especially the holding time of aerial suppression drops (with different suppressants) before the fire burned through

- Quantification of operational costs of suppression resources and/or tactics
- Estimation of the reduction in area burnt dur to suppression efforts and thereby the savings of potential losses.

The overall aim of aerial suppression research is to optimise the operational and cost efficiency of aircraft in fire operations. This can be done primarily through the production of guidelines for suppression resource selection, allocation, deployment and real-time use. Such guidelines will be used to identify the most effective combination of suppression resources for containing the spread of fires and will also assist the selection of resources. Research data could be used to verify the effectiveness of suppression drops (i.e. drop heights, aircraft speed etc), enhance fire fighter safety, and increase the overall efficiency of suppression tactics. The data could also be used for training and improving safety awareness. Methods developed should be suitable for future use in evaluating the effectiveness of the next generation of suppression resources.

A project investigating aerial suppression effectiveness has recently commenced as part of the newly established Bushfire Cooperative Research Centre. The project aims include an updated review of available technologies and their effectiveness. This paper discusses some of the concepts for evaluation the effectiveness of aircraft for fire fighting.

Fire suppression capacity

The aim of fire suppression is to minimize impacts from unwanted fires. Fire suppression resources include: labour or ground crews, management and organisational skills and technology (hand tools, ground transport, heavy equipment and aircraft). Ground crews are the essential ingredient with technology offering options to increase their suppression capacity. It is important to stress that ground crews have a key role and cannot be substituted. Aerial suppression provides a temporary holding role, rather than extinguishing fires. Follow-up by ground crews before the fire burns through the drop zone is essential.

The factors influencing the effectiveness of aerial fire suppression are fire intensity, fuel and vegetation characteristics and aircraft specification. The Australian experience, backed by local research (McCarthy 2003, Robertson *et al*. 1997, Loane and Gould 1986, Rawson and Rees 1983) has shown that firebombing will be about as effective in halting the forward spread of fires as experienced ground crews with bulldozers and tankers.

With regards to fire intensity Project Aquarius found that forty per cent of the area savings by the large airtankers (e.g. DC-6) were on fires with an average head intensity of less than 750 kW/m, whilst another 53 per cent came from fires between 750 and 3000 kW/m. Fires offering the greatest savings were those with a sufficiently high overall rate of spread to cause severe damage but with an intensity at the time of attack within the limits of airtanker effectiveness' (Loane and Gould 1986). The table below provides a summary of the limits of various suppression methods.

Table 1. Limits of different fire suppression methods.

Suppression Method	**Fire Intensity (kW/m)** The intensity at which suppression method is likely to fail on a ten-hectare fire in dry, stringy bark forest.
Hand tools (crew of seven)	800
Bulldozer (2xD6)	2000
Air tanker (DC6)	2500
Ground tankers on a 40 m fire break	3500

Source: Loane and Gould (1986).

Frame work for evaluation of air aerial suppression

The effectiveness of aerial fire suppression depends on many factors, including air travel time, distance from fire, aircraft characteristics, drop characteristics, ambient conditions, availability of support resources, fire intensity, fuel type, pilot skill, suppression agent used (retardant foam or water) and organisational and infrastructure arrangements. Therefore, for an aircraft to provide effective assistance, it must be available at call, rapidly despatched with minimal travel time, with logistical systems in place, air operations effectively integrated into the system and competent personnel available to direct the operation.

Theoretically, the decision on the use of airtankers requires a case specific cost-benefit analysis, or at least a cost effectiveness analysis. A cost effectiveness study does not compare aerial fire suppression to its conventional alternative, but compares the costs for constructing fire lines between alternatives. The problems with economic evaluations in cases like these, where a large number of variables and uncertainty persist, rendering objective evaluation difficult, particularly between approaches that may be very different.

Evaluation of aerial fire fighting requires data from actual operations for evaluation of different drop patterns, suppressant performance in different fuel types and fire intensities. The study should address the following criteria:

Integration
: Ability of airtankers to integrate effectively into the existing fire fighting system involving both ground and air resources.

Response
: The ability of airtankers to carry out rapid deployment and initial attack in specified areas within existing fire fighting operations.

Effectiveness
: The ability of airtankers to accurately deliver suppressants onto the fire line under a range of fire behaviour conditions including different fuel types, terrain, and fire weather.

Capability
: The ability of airtankers performance in delivery- i.e. circuit time, time for first drop, time between drops (i.e. drop rates).

Efficiency

The effectiveness of airtankers to deliver a variety of drop patterns to (a) penetrate various fuel canopies, and (b) coat fuel with suppressant.

Accuracy / Ground Crew Support and Safety

The effectiveness of airtankers to accurately drop suppressant close to the intended target and the response time and safety of ground crews to take action to suppress the fire with aerial support.

Damage evaluation

The reduction of area burnt and hence the saving from potential losses.

Outcomes

The proposed evaluation study will provide information needed to shape a national aerial fire fighting strategy by:

- Raising the awareness of the fire control officers, aerial operations staff, government officials, media and the community on the effectiveness of aircraft for combating bushfires.
- Produce data to be used for training at all levels to improve suppression operation safety awareness.
- Verify the effectiveness of suppression drops (i.e. drop heights, aircraft speed etc) to increase fire fighter safety, and overall efficiency of suppression tactics.
- To develop methodology to allow us to evaluate the effectiveness of "new generation" of suppression resources – i.e. new aircraft platforms, ground equipment, etc
- To provide data and verification of past research work on evaluation of aerial suppression through detailed recording of operations on high intensity wildfires.

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