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# Identification of physically demanding tasks performed during bushfire suppression by Australian rural firefighters

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ABSTRACT

*Purpose:* To identify and characterize the physically demanding tasks undertaken during multi-day wildfire (known as bushfire in Australia) suppression by Australian rural firefighters.
*Methods:* During semi-structured group interviews, thirty-one experienced male firefighters reviewed 53 firefighting tasks that could be performed during tanker-based bushfire suppression. Participants were asked to nominate the most physically demanding tasks and then define their typical frequencies, durations, operational importance and the dominant actions and activity types in each task.
*Results:* Seven tasks were identified as physically demanding. They were further categorized into three hose and four handtool (e.g., rakehoe) related activities. These tasks were assessed as moderately important to critical and were thought to occur less than one up to 700 times in a four-month bushfire 'season'. Each task's duration was estimated to last approximately 2–30 min depending on the task. Dominant actions were carry, drag, dig/rake actions in seven, three and four of the demanding tasks, respectively. 'Strength-endurance' was the dominant activity type for five of the seven tasks.
*Conclusion:* Seven fireground tasks, three using a hose and four using handtools were classified as physically demanding by incumbent firefighters. The combination of hose and handtool work indicates that the tanker-based bushfire suppression tactics used by Australian rural firefighters appears to be a hybrid of structural and wildfire firefighting techniques and may require a dedicated physiological analyses before the job demands for these firefighters can be quantified.


## 1. Introduction

Wildland fires are an annual threat to communities in Australia, North America, and Southern Europe (Hunter, 2003; Hyde et al., 2008; Schmuck et al., 2004). Each of these continents have suffered catastrophic fires in the past decade (Bushfire Co-Operative Research Centre, 2009; Hunter, 2003; Hyde et al., 2008; Schmuck et al., 2004). The frequency, severity and duration of these fires are also increasing (Hennessy et al., 2005). The prospect of more frequent and longer fires places increasing demand on wildland firefighters worldwide as they strive to safeguard people and property. Safeguarding Australians from the annual threat of bushfires are volunteer and career firefighters from Australia's fire and land management agencies (McLennan, 2004). Fire crews from land management agencies primarily rely on 'dry' fire suppression techniques to curtail the spread of fire (AFAC, 2002). These suppression tactics comprise clearing combustible fuel (e.g., small shrubs, plant litter) to create fire breaks of bare earth by earth moving machinery (e.g., bulldozer, grader) and teams of firefighters using handtools (e.g., rakes, chainsaws; AFAC, 2002). Previous research has quantified the core job tasks (AFAC, 2002), work patterns (Budd et al., 1997a), and physiological responses (Budd et al., 1997b) of the dry fire suppression techniques employed by land management fire crews. In contrast, far less is known about the work demands faced by the 207,000 rural fire service volunteers (McLennan, 2004) who provide the backbone of Australia's bushfire safeguards.

Close inspection of volunteer fire agency training manuals in fire-prone south eastern Australia (e.g., Bush Firefighter Workbook, 2003; Wildfire Firefighter: Learning Manual, 2006) reveals that whilst crews can use suppression techniques favoured by land management agencies, rural fire service crews appear to primarily

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work from fire trucks (locally referred to as tankers) carrying water or other fire suppressants. The volunteer firefighters use fire hoses connected to the tankers to deliver the fire suppressant onto the fire or surrounding burnt debris (Bush Firefighter Workbook, 2003; Wildfire Firefighter: Learning Manual, 2006). Without information on the work demands for this method of fire suppression, fire agencies cannot accurately prescribe fitness for duty, hydration, nutrition or training guidelines to preserve the health and safety of their personnel. Understanding the work demands faced by Australia's rural fire service volunteers may also be valuable for fire agencies in North America and Europe who may use such information to educate the personnel they send to support Australian rural fire crews during large-scale multi-day bushfires.

The vast majority of Australian rural fire service volunteers currently do not undergo physical selection (i.e., fit for duty) tests (McLennan, 2004). Physical selection tests primarily aim to reduce the rate of job-related injury associated with physically demanding occupations (Shephard and Bonneau, 2003). Identifying and characterizing the physically demanding tasks faced by Australian rural fire service volunteers may, therefore, be the first step towards developing and implementing valid physical selection tests for these workers. Alternatively, the information can be used to develop less formal guidelines regarding the fitness requirements and key competencies for rural fire service personnel.

A first step in quantifying the inherent work demands for rural fire service volunteers fighting bushfires is to conduct a job task analysis (Sharkey and Davis, 2008). Though direct observation of work behaviour is preferred (Hughes et al., 1989), conducting such observations during emergency bushfire deployments could be distracting for fire agencies and potentially dangerous for researchers. A more practical and safer approach for a job task analysis is to compile an inventory of all job tasks that could be performed in the occupation after reviewing position descriptions, training manuals and consulting with experienced personnel (Sharkey and Davis, 2008; Payne and Harvey, 2010). After a job inventory has been compiled, semi-structured interviews of incumbent personnel and supervisors or large surveys of incumbent personnel can be used to determine the operational importance, frequency, duration, and perceived physical demand of each job task (Sharkey and Davis, 2008).

At present, a job task analysis of the bushfire suppression duties performed by Australian volunteer rural fire service crews has not been published. According to an internal report by Dwyer and Brooker (2005), firefighters nominated hose dragging, rake (i.e., handtool) work, carrying a knapsack, and lifting equipment as the most physically demanding tasks performed during bushfire deployments. The operational importance, frequency, and duration of the tasks were not reported as the responses were variable across the interviewees ($n = 16–20$; precise number not reported; Dwyer and Brooker, 2005). Identifying the most physically demanding tasks directly (Dwyer and Brooker, 2005) is a departure from other job task analyses (e.g., Taylor and Groeller, 2003) who often combine operational importance, frequency, and difficulty (an alternative to perceived physical demand) to identify critical tasks. The multiplier approach may, however, misclassify a physically demanding task as not critical if it does not occur frequently. Alternatively, the model used by Dwyer and Brooker (2005) where physically demanding tasks are identified first and then their importance, frequency, duration (Hughes et al., 1989), their principal actions (i.e., lift, carry, push, pull, etc; Rayson, 1998) and underlying fitness or activity components (i.e. strength, endurance; Hughes et al., 1989) are characterized has been used to develop physical selection (or performance) tests for military personnel (Rayson, 1998; Vikers and Hodgdon, 1999) and correctional officers (Hughes et al., 1989). However, such concepts from the model (Dwyer and Brooker, 2005) have not been utilized in the firefighters. Thus, the aim of the current study was to identify the most physically demanding tasks performed by Australian rural fire service volunteers during bushfire suppression and then characterize their importance, frequency, duration, principal actions and underlying fitness or activity components.

## 2. Methods

### 2.1. Participants

Thirty-one male Australian volunteer rural firefighters with membership of minimum five years with the Country Fire Authority participated in this study. These participants responded to a call for research volunteers posted at regional fire agency headquarters. The participants represented eight of the twenty-one Country Fire Authority 'regions' across Victoria. To be eligible, participants were required to have attended a major campaign (i.e., multi-day) fire within the last two years and were operationally accredited for tanker-based bushfire suppression. All experimental procedures were approved by the Deakin University Human Research Ethics Committee prior to the start of the study.

### 2.2. Job inventory

Following a review of the fire agency training manual (Wildfire Firefighter: Learning Manual, 2006), a job inventory list of 49 core firefighting tasks was developed in consultation with two senior operational firefighters and three training officers. The inventory list incorporated feedback from these personnel to reflect all physical bushfire suppression tasks that could realistically be performed by crew members deployed to a multi-day bushfire. These five personnel were only used in the consultation phase and were not involved in the semi-structured interviews conducted thereafter.

### 2.3. Experimental protocol

Participants attended one of the six semi-structured group interviews which were conducted at three separate locations across Victoria. At the beginning of each interview session, participants were presented with the job inventory list of 49 tasks and invited to add any additional physical bushfire suppression tasks they felt were missing. The first interview session group identified four additional tasks which were subsequently incorporated to form a final job inventory list of 53 tasks (Table 1). Each subsequent group confirmed that the revised task list of 53 tasks accurately depicted all physical activities encountered during tanker-based suppression of multi-day bushfires.

Participants in each semi-structured interview session were instructed to individually identify from the task list the tasks that were most physically demanding and generic to all firefighters (i.e. not limited to specific roles such as chainsaw operator, for instance). Thereafter, the participants were asked to assess each of the 53 tasks for operational importance, frequency, duration, distance, action and activity categories as per the questions depicted in Table 2.

Action categories of lift, carry and climb were adapted from Rayson (1998). Additional categories (e.g., suppress – using a handtool to extinguish smouldering debris) were included to reflect tasks normally present in the job task analyses of structural firefighting (Gledhill and Jamnik, 1992) and wildfire fighting using handtools (Sharkey, 1997). To describe the physical actions performed during multi-day bushfire suppression work, action categories of suppression, including static hold, drag, and assembly of equipment, were added in consultation with senior operational firefighters. Activity categories (adapted from Hughes et al., 1989; U.S. Department of Health and Human Services, 1996) comprising