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# Effects of disturbance on population dynamics of the threatened orchid *Prasophyllum correctum* D.L. Jones and implications for grassland management in south-eastern Australia

*Fiona Coates*[a,*], *Ian D. Lunt*[b], *Raymond L. Tremblay*[c,d]

[a]*Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, P.O. Box 137, 123 Brown Street, Heidelberg, Vic. 3084, Australia*
[b]*The Johnstone Centre, Charles Sturt University, P.O. Box 789 Albury, NSW 2640, Australia*
[c]*National Herbarium of Victoria, Royal Botanic Gardens, Birdwood Avenue, South Yarra, Vic. 3141, Australia*
[d]*Department of Biology, 100 Carr. 908, University of Puerto Rico – Humacao campus, Humacao, PR 00791, USA*

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ABSTRACT

Natural and anthropogenic disturbances can have dramatic consequences for population growth, particularly for small populations of threatened plants. We analysed census data for the largest population (124 individuals) of the critically endangered orchid *Prasophyllum correctum* between 1992 and 2003, to identify environmental factors associated with annual changes in emergence and flowering, and to develop management prescriptions for its conservation. Fire frequency effects were analysed by comparing life stage transition matrices between plants subject to <3 year and >3 year fire intervals; climate effects were investigated using cross-correlation plots to relate total emergence, and numbers of sterile and flowering plants to rainfall, and grazing impacts were investigated by experimentally protecting plants in 1996–1998. Plants rarely emerged for more than two consecutive years or flowered for more than a single year. The total number of plants that emerged was significantly negatively correlated with autumn/winter rainfall in the previous year, perhaps due to on-going competitive effects of increased grass growth under wetter conditions. The proportion of reproductive adults was greater when fire intervals were <3 years, and a greater proportion of the population remained dormant and non-reproductive when fire intervals exceeded 3 years. Grazing had a significant negative effect on the orchid population in the first 2 years after fire. A management regime that includes frequent burning is likely to benefit conservation of the population by reducing competition from grasses, shortening dormancy periods, reducing mortality, enhancing flowering and, by implication, possibly increasing recruitment.



* *Corresponding author:* Tel.: +61 3 9450 8618; fax: +61 3 9450 8799.
E-mail address: Fiona.Coates@dse.vic.gov.au (F. Coates).
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## 1. Introduction

Orchids represent a large proportion of plants at risk in Australia, comprising 10% of rare or threatened species in Victoria (Backhouse and Cameron, 2005). Many endangered orchids have extremely small population sizes (<100 plants), and their in situ conservation poses a major challenge to conservation management agencies.

Large variations in population size in terrestrial orchids are widely reported in the literature, and irregular patterns of emergence, flowering and fruiting appear to be commonplace, at least in the northern hemisphere (e.g., Tamm, 1972; Hutchings, 1987; Gregg, 1991; Light and MacConnaill, 1991; Falb and Leopold, 1993; Kindlmann and Balounová, 1999; Brzosko, 2002). Typically, terrestrial orchids may remain dormant for one or many years and may emerge from dormancy in either a vegetative or flowering state, although only a limited proportion of the plants emerge above ground annually. Few published studies exist on the population dynamics of orchids in Australia. However, observations and unpublished data (Department of Sustainability and Environment, Victoria) indicate that the size and density of many populations fluctuate occasionally or regularly, often in response to environmental disturbance events (e.g. Barnett, 1984; Calder et al., 1989; Cropper et al., 1989).

Fire, herbivory and climate can affect plant populations at both landscape and local scales. Interactions between large- and small-scale environmental impacts are inevitable at the site level and are particularly important where they affect small populations of threatened species. Fire in particular has been a major force in shaping the current composition and structure of Australian vegetation by consuming plant biomass and stimulating flowering, resprouting and germination (Gill, 1981; Auld and O'Connell, 1991; Whelan et al., 2002; Thomas et al., 2003). Prior to European settlement, fires originated from lightning strikes or were deliberately lit by Aborigines (Bowman, 1998; Kershaw et al., 2002). In contemporary times however, natural resource managers have attempted to re-establish ecological fire regimes to maintain and enhance biodiversity values (Keith et al., 2002). A number of studies have demonstrated that fires promote flowering in orchid populations, including *Calopogon multiflorus* Lindl. and *C. pallidus* Chapm. in Florida; *Corybas carsei*, *Prasophyllum* aff. *patens*, *Thelymitra cyanea* and *Pterostylis paludosa* in New Zealand, and *Thelymitra epipactoides* F. Muell. in south-east Australia (Calder et al., 1989; Goldman and Orzell, 2000; Norton and De Lange, 2003).

Grazing by animals can also have a profound effect on orchid population dynamics. The removal of buds and shoots can significantly influence emergence and flowering and a reduction in photosynthetic area in one year may render plants unable to assimilate sufficient carbon reserves to flower in the subsequent year (Whigham and O'Neill, 1991; Brzosko, 2002; Gregg, 2004). The severity of grazing is also important. For example, Gregg (2004) found that a moderately grazed population of *Cypripedium reginae* Walter recovered significantly faster than a heavily grazed population in terms of equilibrium proportions of life states, flowering and plant size.

Some orchid populations respond to variation in annual rainfall, with reduced flowering after drought in the same or previous year (Wells, 1981; Inghe and Tamm, 1988; Wells and Cox, 1991; Light and MacConnaill, 1991), and enhanced flowering following periods of higher rainfall (Hutchings, 1987; Light and MacConnaill, 1991; Sieg and King, 1995; Kéry and Gregg, 2004). Flowering behaviour can be influenced by interactions between rainfall and temperature, site-specific characteristics and seasonal variation within years (Light and MacConnaill, 1991; Sieg and King, 1995; Wells et al., 1998).

Orchid population dynamics are also affected by habitat management, particularly where management activities remove competing vegetation. Removal of plant biomass by mowing, burning, grazing or artificially creating canopy gaps affects orchid population dynamics, mainly by promoting greater leaf area, flowering and seed set but also by creating an open, more suitable environment for seedling establishment (Hutchings, 1987; Waite and Hutchings, 1991; Kull, 1995; Hutchings et al., 1998; Wheeler et al., 1998; Cropper et al., 1989; Willems and Melser, 1998; Willems et al., 2001; Wotavová et al., 2004).

*P. correctum* (gaping leek orchid) is an endangered terrestrial orchid restricted to two small populations in Victoria, Australia. The largest population occurs in a small grassland remnant that has historically been subject to frequent burning and little grazing. The recovery strategy for *P. correctum* aims to increase population size, mainly through habitat management, by manipulating fire regimes (Coates et al., 1999). However this strategy requires considerable information on the influence of seasonal climatic variations, burning and other disturbances, on the orchid's population dynamics.

Plant demographic studies are useful tools for understanding and predicting population behaviour and for evaluating the response of orchid populations to exogenous influences, particularly management (Waite, 1989; Hutchings, 1990; Shefferson et al., 2001; Kéry and Gregg, 2003, 2004). In this study, we used demographic census data to: (i) quantify patterns of appearance of life stages and plant performance in the largest *P. correctum* population and determine if they are autocorrelated and cyclical; (ii) compare the effect of two different fire frequencies on population dynamics; (iii) evaluate whether rainfall and grazing have a significant influence on plant emergence, flowering and size, and (iv) recommend a management regime to enhance the orchid's conservation and maintain grassland plant diversity. Given the general ecological recognition of the need for regular biomass removal to maintain plant densities in productive grasslands (Grime, 1973; Connell, 1978; Collins et al., 1999; Burke and Grime, 1996; Julita and Grace, 2002; Lunt and Morgan, 2002) and the history of regular burning at the site where the largest *P. correctum* population occurs, we hypothesised that frequent disturbance would be necessary to promote recruitment, emergence, flowering and plant survival.

## 2. Methods

### 2.1. The species

*P. correctum* is a critically endangered orchid ( *sensu* IUCN 2000), consisting of fewer than 150 plants known from only two populations in south-eastern Australia. It has a single terete leaf that grows to about 30 cm tall with 10–20 greenish