IMPACTS AND MANAGEMENT OF *CENCHRUS CILIARIS* (BUFFEL GRASS) AS AN INVASIVE SPECIES IN NORTHERN QUEENSLAND

Thesis submitted by
Janice JACKSON B.Agr.Sc. (Hons 1) (U.Q)
in May 2004

For the degree of Doctor of Philosophy
In Tropical Plant Sciences
School of Tropical Biology
James Cook University

STATEMENT OF ACCESS

I, the undersigned, the author of this thesis, understand that James Cook University will make it available for use within the University Library and, by microfilm or other means, allow access to users in other approved libraries. All users consulting this thesis will have to sign the following statement:

> In consulting this thesis I agree not to copy or closely paraphrase it in whole or in part without the written consent of the author; and to make proper public written acknowledgement for any assistance which I have obtained from it.

…………………………………………… ……………………………

Janice Jackson

STATEMENT OF SOURCES DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

…………………………………………… ……………………………

Janice Jackson

Abstract

Cenchrus ciliaris L. (buffel grass) (Poaceae) is recognized as one of Australia's most serious environmental weeds. This introduced grass is associated with loss of native species and alteration of fire regimes. However there is considerable controversy regarding its weed status as it is also highly valued as a pasture species for arid and semi-arid zones. Quantitative studies are needed to determine its ecological effects. In addition, its spread into non-target areas, including conservation reserves, means that there is considerable interest in strategies for containing or eliminating *C. ciliaris*. These two issues, the effects of *C. ciliaris* on native species and strategies for managing *C. ciliaris*, are the focus of this thesis.

The relationship between *C. ciliaris* and herbaceous species richness was investigated in two studies at a range of scales up to 64 m^2 in open woodlands in north-eastern Queensland. In the first study, the herbaceous species composition of sites with and without *C. ciliaris* were compared. *Cenchrus ciliaris*-dominated sites had fewer herbaceous species than non-*C. ciliaris* sites at all scales investigated and this pattern was found for the major plant groups (perennial grasses, legumes and other forbs) present. In the second study, the relationship between varying levels of *C. ciliaris* biomass and species richness was investigated at one site. The relationship between varying levels of a dominant native grass, *Bothriochloa ewartiana* (Domin) C.E. Hubb. (Poaceae), and species richness was also determined for comparison with the *C. ciliaris* biomass-richness relationship. In this study, species richness was negatively associated with increasing *C. ciliaris* biomass at some scales and it appeared that *C. ciliaris* had a greater effect on richness than *B. ewartiana*. The negative association between *C. ciliaris* and species richness is consistent with the view that invasion by *C. ciliaris* poses a threat to biodiversity. However, the precise cause of the relationship has yet to be determined.

The strategic use of fire offers potential to control unwanted species. To evaluate fire as a tool for reducing *C. ciliaris* abundance, the effects of season of burning on two *C. ciliaris*-dominated communities in north Queensland were investigated. Three treatments were imposed in small plots at both sites: early dry season burn, late dry season burn and control (no burn). These treatments were selected to exploit differences in fire characteristics and vegetation responses to fire associated with different season of burning. The herbaceous species present and their cover were recorded before and after the fires and post-fire seedling emergence was monitored. To help understand the mechanisms by which fire may alter community composition, burning treatment effects on the availability of establishment sites and propagules were also investigated. Fire affects establishment site availability by

reducing resident plant competition, by altering nutrient availability and by altering soil surface condition. Three studies were conducted to investigate treatment effects on establishment sites: (1) *C. ciliaris* plants were monitored to determine mortality, (2) a bioassay technique was used to assess plant nutrient availability and (3) a 'pot' experiment was conducted to examine the effects of different soil surface cover on seedling emergence to help predict the effects of litter removal on emergence patterns. Fire effects on propagule supply were investigated by monitoring flowering in *C. ciliaris*. A germination method was used to determine soil seed bank composition.

Overall, burning had little effect on these communities. The intensities of the fires were low to moderate (300-3030 kWm^{-1}). At Dalrymple there was an unexpected reversal of intensities; the mean intensity of early dry season fires was higher than that of late dry season fires. The fires caused no major changes in composition, few *C. ciliaris* plants were killed and no changes in nutrient availability or seed bank composition were detected. Although these short-term studies of single fires do not allow definitive recommendations regarding the use of fire to manage *C. ciliaris*, they provide information that will aid future research. I found that fire could kill *C. ciliaris* plants and reduce *C. ciliaris* cover. This contrasts with the positive fire feedback model generally proposed for *C. ciliaris*. *Cenchrus ciliaris* mortality was higher with early dry season burning at Dalrymple, suggesting that higher intensity fires will be more effective in eliminating *C. ciliaris* plants and/or that *C. ciliaris* plants may be more susceptible to fire at this time because they have not fully senesced. Apparent low densities of perennial grass seeds in the seed banks of these communities may be exploited: over-sowing with native perennial grasses after fire may encourage shifts in perennial grass dominance.

There is an urgent need for management strategies that reduce, prevent or contain invasive weed invasion. Further work is required to investigate the application of fire regimes in *C. ciliaris*-dominated communities. Of particular interest are differences in growth and/or phenology between *C. ciliaris* and native species in these grasslands that may be exploited to disadvantage *C. ciliaris*.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

This project would not have been possible without the support of Paul Williams, Queensland Parks and Wildlife Service. Paul provided access to field sites and assistance with field work and I thank him very much for his support and enthusiasm. Thanks also to QPWS staff Benton Haigh, Ken McMahon and Eddie Staier who assisted with the fire work and others who assisted with access to field sites and with field work including Brett Abbott, Peter Allen, Jeff Corfield, Mandy Kotzman, Brigid McCallum, Mike Nicholas, Peter O'Reagain, Ian Radford, Gary Rogers, Lynn Walker, Lindsay Whiteman and Mike Whiting. John Childs, while director of the Tropical Savanna CRC, approved funding to support some of this work. I would also like to thank him for financial support to attend a conference in Townsville and a writing course in Darwin. Thanks also to Brett Abbott for regular help with computer matters, Christy Matthes for library assistance and Chris Stokes for informative discussions regarding species area curves among other things. Many thanks to Betsy Jackes for seeing me through the university hoops. She and Tony Grice provided valuable feed back during the writing of this thesis. I would also like to thank John McIvor, John Ludwig and other reviewers for their advice on an associated manuscript that assisted with the writing of the second chapter of this thesis. The various studies were undertaken in consultation with a very patient statistician. Thank you Bob Mayer, senior biometrician with the Department of Primary Industries. Finally, I would like to thank friends, family and my husband for their support.