The view looking north of Blackbutt Plateau and, immediately to its north, upper Koonyum Range located in the southwest corner of Nullum State Forest. This State Forest includes the rest of the forested areas in the photograph. The complex of old-growth forest communities on the Plateau was the subject of this research project.

THE NATURE OF THE BOUNDARIES BETWEEN TALL EUCALYPT FOREST AND WARM TEMPERATE RAINFOREST IN THE UNLOGGED COMPARTMENTS OF NULLUM STATE FOREST IN NORTHEASTERN NEW SOUTH WALES

by

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PREAMBLE

In the years leading up to 1984, I had often paused to admire the majestic cliffs of a rhyolite massif projecting from the southern slopes of Mount Jerusalem, a peak on the southern rim of the great Mount Warning caldera in the north-east corner of New South Wales. The few outings in the grand forest growing on the rhyolite had always been a delight because of the plentiful wildlife and the tranquillity of the forest ambience. The mere presence of the huge Blackbutt trees, just one after another, infused me with an enormous sense of well-being to the point of being inspirational. It was therefore with considerable sadness that we learned one April morning in 1984 that the sound of detonations we had been hearing was, in fact, the Forestry Commission of NSW commencing the construction of a road up the face of the rhyolite in order to undertake a complete cut-over of the tall blackbutt forest. The logging operation was to be carried out as quickly as possible and, but for the staunch opposition to the project by the local residents, the forest would have been completely cut out in about three months. As it was, politicians were alerted and it was agreed to place an interim moratorium on the operation such that it was put back to 1989. In the meantime exceedingly heavy rainfall in 1987 and 1988 found weaknesses in the road construction such that several landslides completely cut off the newly contrived vehicular access to the forest. This development, along with the State Government's decision that the logging of designated old-growth forests should require an environmental impact assessment, further delayed the project and enabled me, with the support and assistance of the University of New England and, I should say, the complete cooperation of the Forestry Commission, to undertake some research in the endangered forest complex before it was severely disturbed. A feature of the old-growth forest was the range of distinct plant associations, some large, some small, which comprised the overall forest complex. It interested me why so many plant communities had formed in such a relatively small area and also what were their natural dynamics. So, as a first step I resolved, by compiling a detailed analysis of the vegetational response, to study the boundaries between the two major plant communities, the tall Blackbutt forest and the warm temperate rainforest.

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While this project has been a lone toil, several people have made critical contributions to its progress, direction and enjoyment. I wish to thank my supervisor, Dr John Duggin who guided me in the planning of the experimental design, was always supportive during times of doubt and adroitly managed the financial and administrative side of the project. The technical staff of the Department of Ecosystem Management assisted with the provision of accurately calibrated field equipment and also provided guidance with several laboratory procedures. Terry Cooke provided the facilities and the instruction required for the digitizing of the hygrothermograms and Michael Roach drew the various maps of the study area. Elsewhere within the University I thank the staff of Dixson Library for professional pursuit of many obscure publications and a number of colleagues who knowingly or otherwise provided ideas and perspectives. I thank State Forests (then the Forestry Commission of N.S.W.) for permission to conduct this research on their estate and their personnel who, while remaining in the background, were always available and ready to assist. The field work was made immensely more manageable due to the assistance I received from Dorothee Lubecki, Renata Mattmüller and Thomas Mielke. The aerial photography was conducted expertly by Bill Mills who took many photographs for me over two days of flying. Additional colour photos were loaned to me by Byron Shire Council and the National Parks and Wildlife Service while the (then) Department of Lands despatched sets of historical aerial photos of the study area. Mike Desalis at the Bureau of Meteorology kindly spent time helping me extract the climatic data measured at the Byron Bay recording station. I would also like to acknowledge the National Parks and Wildlife Service who trained me in the use of S-PLUS, the main software package used for analysis and graphics. I am grateful for the forbearance shown by my children for all those fatherless hours. Most of all I want to thank my wife, Gwynn Guyatt, who always encouraged me, assisted with some field work and stoically shouldered much of my burden of domestic responsibilities. In many ways she made it possible. For most of the duration of this study I was supported by a Commonwealth Postgraduate Research Award.

CERTIFICATE OF ORIGINALITY

I certify that the substance of this thesis has not already been submitted for any degree and is not being currently submitted for any other degree.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

............[redacted]..

signature

PREFATORY NOTE

A large amount of botanical nomenclature is used in this manuscript. The names of specific taxa and all family and higher taxonomic levels are in accordance with the Flora of New South Wales (Harden 1990, 1991,1992, and 1993). To maintain fluency, authorities of scientific names are omitted entirely from the text but are shown in the full species list comprising Appendix I. Terms such as "strategy" or "avoidance" are used strictly in the non-teleological sense.

ABSTRACT

This study examined the nature of the boundaries between montane wet sclerophyll forests (WSF) and warm temperate rainforests (WTRF) in far northeast New South Wales. The location was Nullum State Forest, a section of which contained approximately 500 ha of forest which, through isolation due to difficulty of access had remained unlogged. This particular forest community was essentially undisturbed and field evidence suggested a fire frequency cycle in the order of over 100 years. Given these conditions, the forest boundaries were considered "natural". The rainforest occurred as small stands of not more than 10 ha while the WSF occurred as larger stands which were interconnected via other types of sclerophyll forest. The WSF was dominated by *Eucalyptus pilularis* with significant populations of *Syncarpia glomulifera* and *Allocasuarina torulosa*. The WTRF patches were variously dominated by *Ceratopetalum apetalum* or *Schizomeria ovata* or else a mix of several species. Several transects comprising contiguous 0.1 ha plots were laid down across the study area from WSF patches through the transition zone into WTRF. From within the transects the measured attributes of the boundaries and the adjacent forests included elements of the microclimate, the abundances of all vascular plant species, the forest structure, the litterfall and aspects relating to the dynamics of the boundaries. The results show that the transitional zone is distinct from the wet sclerophyll forest and the warm temperate rainforest, exhibiting features which are absent from those two forest types. Several other measured attributes of the transition zone, however, were found to be mid-way between the values for open forest and closed forest.

The vascular plant species richness of the TZF was found to be significantly greater than either the WSF or the WTRF, but the species abundances were generally lower. Several species, notably *Acacia orites, Callicoma serratifolia, Canarium australasicum* and *Melicope hayesii,* in conjunction with a number of scandent taxa, achieve their best development in the TZF. Pattern analyses were undertaken for all floristics data and generalized additive predictive models (GAMs) were obtained for every species.

The structure of the TZF is different to the other forest types with essentially a two-tiered canopy, the upper tier consisting of tall

E.pilularis and the lower tier consisting of a mix of sclerophyllous and mesophyllous taxa. The understorey in the TZF is the least well developed. The overall complexity of the structural stratification in the TZF is mid-way between that of the WSF and WTRF.

Litterfall was compared for each forest type and the findings related to those of other studies. Total annual litterfall in the TZF was exactly mid-way between that of the WSF and the WTRF. Litterfall results were higher than most other reports but found to be consistent with expectations when plotted against rainfall.

Microclimate measurements were taken weekly at separate points along the vegetation gradient and included temperature, humidity and rainfall. The temperature in the transition zone forest (TZF) was found to have significantly lower ground-level minima than the other forest types during both summer and winter. This was attributed to the different mix and abundances of the understorey flora. The WTRF was found to ameliorate only the upper end of the temperature range as the lowest maxima were recorded in that forest type while minima were not significantly different to WSF readings. The temperature gradient is not a gradual change from WSF to WTRF but has special characteristics in the transition zone which were confirmed by the use of both maximum-minimum thermometers and hygrothermographs. Relative humidity is marginally higher in the TZF than the WTRF and both are more humid than the WSF. The vapour pressure deficit is also lowest in the TZF. Using an external data set for wind and cloud, in conjunction with topographical data and horizon angles, the variation in annual insolation was calculated across the study area. The WTRF patches were found to receive more daily direct sunshine than the WSF but most of this was obtained during the morning drying period while the WSF occupied the sites which obtained most direct radiation during the afternoon heating period.

The forest boundaries were assessed as having reached a point of stability. Stability is argued as being a legitimate state for either sharp or diffuse boundary types. Predictive models for both boundary canopy floristics and distribution of boundary types were obtained. These models, albeit preliminary, supported the thesis of continued stability in the absence of perturbation. The study acknowledges the uncertainty concerning forest response to elevated levels of CO_2.

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