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Regional habitat selection of large gliding possums at forest stand and landscape scales in southern Queensland, Australia I. Greater glider (*Petauroides volans*)

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Abstract

Forest stand and landscape scale habitat selection of the greater glider (*Petauroides volans*) was investigated at 506 survey sites sampling a variety of forest types in southern Queensland, Australia. While greater gliders were detected in a wide range of forest types, they were most abundant in the more productive, tall eucalypt forests. The generated model predicted that *Corymbia citriodora* and *Eucalyptus tereticornis* were important in greater glider habitat selection, as were live hollow-bearing trees, a currently limited resource in southern Queensland. The model also predicted a negative response by greater gliders to more intensive harvesting in selectively logged stands. The introduction of a new, more intensive harvesting regime in areas of greater glider habitat in south-east Queensland will therefore have a significant impact upon glider populations, unless current habitat tree prescriptions are adjusted to specify the retention of large *C. citriodora* and *E. tereticornis* trees, and species that rapidly form hollows. The retention of patches and corridors of mature eucalypt forest will also be important to ensure greater glider conservation in intensively logged forest landscapes of southern Queensland. Greater glider densities were also influenced by one landscape scale variable, proportion of cleared habitat within a 1 km spatial extent. Densities of greater gliders were predicted to decline to less than one glider per 3 ha if >15% of habitat was cleared in the landscape. Recent amendments to tree clearing legislation in Queensland, whereby all broadscale clearing will be phased out by the end of 2006, will greatly facilitate greater glider conservation in remaining habitat patches. However, the management of structural characteristics important for greater gliders within forest remnants will be essential for ensuring habitat suitability for gliders in the long term.

Keywords: Forest management; Forest structure; Selection logging impacts; Hollow-bearing trees; Landscape context

1. Introduction

The Australian National Forest Policy Statement (Commonwealth of Australia, 1992) sets goals for the ecologically sustainable management of public and private forests. By doing so, the Policy formally commits forest management agencies to develop strategies and harvesting prescriptions to ensure conservation of forest wildlife. The Queensland Code of Practice for Native Forest Timber Production (Environmental Protection Agency, 2002) defines the procedures and standards to achieve protection of environmental values at an operational level, consistent with the National Forest Policy statement. Schedule 6 (Habitat Trees) of the Code of Practice outlines the requirements for the retention and maintenance of hollow-bearing trees for five broad forest types. In recognition of studies demonstrating greater glider (*Petauroides volans*) den tree requirements (Kehl and Borsboom, 1984; Lindenmayer et al., 1990) the Code specifies six live hollow-bearing trees per hectare to be retained in coastal wet to moist hardwood forests and coastal/inland dry sclerophyll forests where the greater glider is expected to occur. Four live hollow-bearing trees per hectare must be retained in coastal/inland dry sclerophyll forests where the greater glider is not expected to occur. In Queensland, not only is information required to identify the distribution of the greater glider, but also to confirm that the specified number of hollow-bearing trees for retention is adequate across greater glider habitat.

The greater glider is the largest of Australia's marsupial gliders. The glider feeds predominantly on eucalypt foliage, a low nutrient and highly toxic diet which influences the sedentary and solitary socio-ecological traits of the species (Kavanagh and Lambert, 1990; Foley et al., 2004).

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Home ranges are typically small, ranging from 1 to 3 ha, and tend to vary in response to habitat (Comport et al., 1996; Pope et al., 2004; Kavanagh and Wheeler, 2004). The greater glider has been identified as a potential indicator species of forest disturbance for long-term monitoring purposes (Kavanagh and Stanton, 2005).

Regional greater glider distribution has been shown to be patchy across the forests of north-east and south-east New South Wales, in response to variation in habitat attributes such as forest type, abundance of hollow-bearing trees and logging disturbance (Braithwaite, 1983; Kavanagh et al., 1995; Kavanagh and Bamkin, 1995; Goldingay and Daly, 1997; Kavanagh and Stanton, 2005). Throughout the range of the greater glider, studies have documented its sensitivity to timber harvesting—specifically the reduction of hollow-bearing trees or old-growth forest containing high densities of hollow-bearing trees (Lunney, 1987; Milledge et al., 1991; Lindenmayer et al., 1990; Incoll et al., 2001; Kavanagh and Wheeler, 2004). The degree of impact appears to depend upon the forest type and associated intensity of the silvicultural regime (Kavanagh et al., 1995; Kavanagh and Webb, 1998; Kavanagh, 2000).

The collection and analysis of quantitative habitat and disturbance data at the forest stand and landscape scales have rarely been undertaken for greater gliders during regional studies. This information should be looked at in conjunction with any regional description of habitat, to identify any potential response gliders may have to features at finer scales. As opposed to regional environmental variables that cannot be readily altered (e.g. mean annual rainfall), heterogeneity of habitat is pronounced at the patch scale due to variation caused by management (e.g. logging) or natural disturbance (e.g. wildfire) (Mladenoff et al., 1993; Catling et al., 1998).

The objective of this study was to describe regional habitat selection of the greater glider in southern Queensland, by constructing statistical habitat models at the forest stand and landscape scales. The identification of thresholds relating to hollow-bearing tree densities and timber removal was of particular interest, given the specific reference to greater glider habitat tree requirements in the Queensland Code of Practice. To date there has been one published account on the distribution of the greater glider in southern Queensland (Eyre, 2004), but no published information regarding habitat selection of the species in the region.

2. Methods

2.1. The study region

The southern Queensland study region covers an extensive area of north-east Australia of approximately 43.7 million hectares, and is bounded by the Brigalow Bioregion to the north and west and the Queensland–New South Wales border to the south (Fig. 1). Approximately 49% of the region is covered by forest and woodland, the majority of the remainder having been cleared for pasture and broad-acre cropping (Queensland Department of Natural Resources, 2000). Extant native vegetation is diverse and ranges from the complex notophyll rainforests and tall eucalypt forests of the coastal lowlands through to cypress pine (*Callitris glaucophylla*), brigalow (*Acacia harpophylla*) and eucalypt woodlands further west.

The dry eucalypt forests of the study region are typically uneven-aged and composed of mixed species. These forests are termed ‘regenerators based primarily on advance growth’ by Florence (1996). This type of regeneration strategy is complex in that regeneration is usually slow, with seedling establishment occurring continuously, although mainly in response to prevailing conditions. In southern Queensland, these forests are managed under a selective harvesting regime. Initially the selection of stems to remove from the stand was based on diameter limits. From the mid-1960s trees were selected based on their growing potential in an attempt to improve the commerciality of the stand, although minimum diameter limits were still used. Suppressed trees with limited growing potential were removed, and minimum spacing for retained trees was introduced (Florence, 1996). Selective logging tends to alter the structure of a forest to create an uneven-aged stand dominated by younger stems (Queensland Department of Natural Resources, 1998; Eyre, 2005). The landscape of the production eucalypt forests of southern Queensland is therefore typified by relatively diffuse edges between patches of forest of a particular age structure and species mix.

2.2. Site selection

The study region was stratified using broad classes of mean precipitation of the driest quarter, minimum temperature of the coldest quarter and geology, and a coverage depicting four subsets of the study area (north-east, north-west, south-east and south-west). The distribution of woody vegetation, mapped in 1997 using Landsat TM at a scale of 1:100 000, was also used to identify areas of extant forest and woodland (Queensland Department of Natural Resources, 2000). The final stratification produced a total of 291 possible environmental domains to survey. The stratification procedure is more fully described in Eyre and Buck (2005).

Environmental domains that encompassed less 0.1% of the entire study region were not sampled, reducing the number of domains to be sampled to 143. Between 2 and 4 sites were located within each of these domains, resulting in a total of 506 survey sites (Fig. 1). Sites were located in the field at least 2 km apart to ensure independence between the site data collected.

2.3. Forest stand and landscape variables

At each site a 200 m × 50 m plot was established to follow the topographic contour, at least 50 m from the point of access. Habitat variables were recorded within either 5 m, 20 m or 50 m of the centre transect and converted to give values per ha (Table 1).

Landscape or contextual variables were generated from digital mapping of remnant vegetation and disturbance (Table 2). Within the study region, forests managed for timber production have been delineated into homogenous zones of