Customizing BIOCLIM to investigate spatial and temporal variations in highly mobile species

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Abstract. The bioclimatic analysis and prediction system, BIOCLIM, has been successfully applied to a wide range of plant and animal species in Australia, Africa and North America. However, BIOCLIM has limitations when the species analyzed is highly mobile and can change its distribution over time. This paper assesses the validity of customizing BIOCLIM to investigate changes in the seasonal distribution of the eastern grass owl in Australia. The results show considerable spatial and temporal differences in the predicted seasonal distribution of the eastern grass owl, which are not evident in the overall predicted distribution. The results also provide new insights into the occasional dispersal of the eastern grass owl from coastal areas into inland Australia. It is suggested that similar modifications of BIOCLIM may prove useful for investigating other highly mobile species and for conservation initiatives aimed at such species.

1. INTRODUCTION

BIOCLIM is a bioclimatic analysis and prediction system initially developed by Nix (1986). Detailed descriptions of the system are provided by Nix (1986) and Busby (1991). In essence, BIOCLIM provides a means to predict the spatial distribution of plant and animal species (e.g. Lindenmayer et al., 1991; Lindenmayer et al., 1996; Campbell et al., 1999; Sumner and Dickman, 1998; Jackson and Claridge, 1999). Whilst BIOCLIM has been mostly used in Australia, it has also been successfully applied in Africa and North America (Lindenmayer et al., 1996).

The predicted distribution generated by BIOCLIM is typically a single map and an accompanying bioclimatic profile represented by a set of climatic indicies (e.g. Lindenmayer et al., 1996, Jackson and Claridge, 1999). One potential problem with this type of output is that the predicted distribution may not accurately reflect the movements of highly mobile species. This is a significant limitation, as BIOCLIM is regarded as an important tool in biological surveys and conservation initiatives (e.g. Busby, 1991, Lindenmayer et al., 1991). Therefore, customizing BIOCLIM to investigate temporal variations in the distribution of highly mobile species may improve the quality of the information generated.

The species investigated in this paper is the grass owl, *Tyto capensis*. Within Australia, the grass owl's distributional range is still incompletely known (Higgins 1999). Until the 1970s it was thought to be limited to coastal areas of Queensland (Schodde and Mason 1981). Today its range is often suggested to be discontinuous, with two centres of distribution: a scattered inland population based in the arid inland drainage system (Lake Eyre Basin), extending to the northern Murray-Darling River Basin; and a subtropical-tropical population spanning north-eastern New South Wales and eastern Queensland, within about 70km of the coast (Schodde and Mason 1981; Hollands 1991; Higgins 1999; Bruce 1999). Following sporadic irruptions, dispersing individuals can be found almost anywhere on the mainland, Torres Strait Islands and even the Indonesian Archipelago and beyond (references in Higgins 1999).

2. METHODS

2.1 Sample localities

Data on locations of grass owls were available from NPWS NSW (2000), which included the Comprehensive Regional Assessments, and from Birds Australia, made up of historical records extracted from the literature and more recent sightings, mainly from their Atlas survey (Historical Atlas pre-1977 and Field Atlas 1977–1981), and a few reports from the Nest Record Scheme, Bird of Prey Watch and Australian Bird Count. A few records were also extracted from the recent literature, most notably Johstone and Storr (1998). Wherever identified, questionable records and duplicates were removed so that only one record per site was used in the analyses. This left a total of 218 records, collected between 1866-2000, to provide the presence/absence data required by the BIOCLIM system for modelling.

2.2 Predictive modelling of distribution

In order to generate a climatic profile and predicted distribution, the bioclimatic analysis program BIOCLIM requires latitude, longitude and elevation data for each record (Busby 1991; Lindenmayer *et al*. 1991). The elevation of each grass owl record was determined from 1:100,000 and 1:250,000 topographic maps, whilst the latitude and longitude for each record was generally supplied with the original data.

We based the 'irruptive range' and 'core' distributions on the maximum and minimum values (i.e., all values, 0-100%) and the 10-90% level in the bioclimatic profile, respectively (e.g., Lindenmayer *et al*. 1991; Sumner and Dickman 1998). The 5-95% level in the bioclimatic profile was also mapped, to indicate areas between the core and the irruptive range where the species was quite likely to be found (e.g., Lindenmayer *et al*. 1996).

2.3 Investigation of temporal shifts in distribution

Seasonal variation in distribution was investigated by segregating the data and generating predicted distribution for each season. After removing records that did not specify the month, the number of records available were: summer (December-January–February) n = 36; autumn (March-April-May) n = 29; winter (June-July-August) n = 63; and spring (September-October-November) n = 68.

3. RESULTS

3.1 Predicted distribution

The predicted potential distribution (Figure 1) indicates that only the coastal and sub-coastal north-eastern records represent the core range of the grass owl in Australia. If the 5-95% level is included this range is extends into fragmented areas of south-east Queensland and far north-eastern NSW within about 600 km of the coast. The remaining, widely scattered inland and far northern records fell into the zone we have termed the irruptive range.

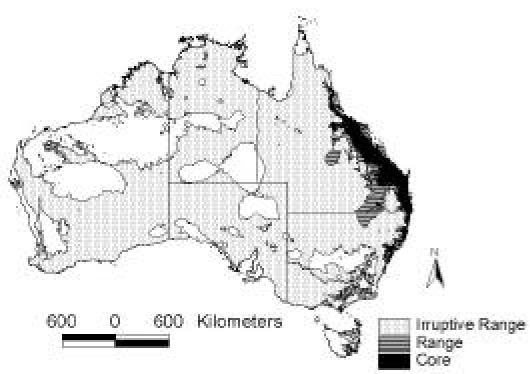

Figure 1: Predicted distribution of the grass owl in Australia.

3.2 Seasonal shifts in distribution

The seasonal predictions (Fig. 2 a-d) show considerable variation. Figure 2a indicates that over much of Australia the summer climate is unsuitable for grass owls, the exception being the coastal north-east. In autumn (Figure 2b), at the 5-95% and 10-90% levels, the range expands somewhat inland and southwards and at the irruptive range level it reaches the northern part of Australia (Fig. 4b). During winter (figure 2c) and spring (figure 2d), at the 5-95% and 10-90% levels the range recedes to the north-east and the irruptive range extends further inland to occupy most of the country.

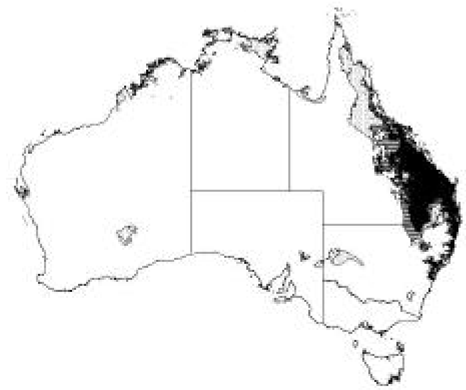

Figure 2a: Predicted distribution for grassowl during summer

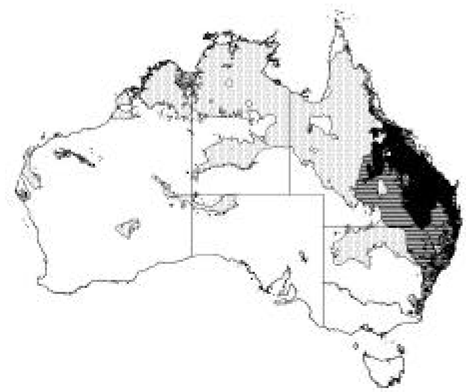

Figure 2b: Predicted distribution for grassowl during autumn.

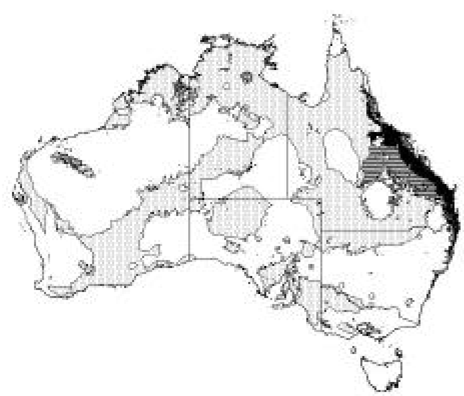

Figure 2c: Predicted distribution for grassowl during winter.

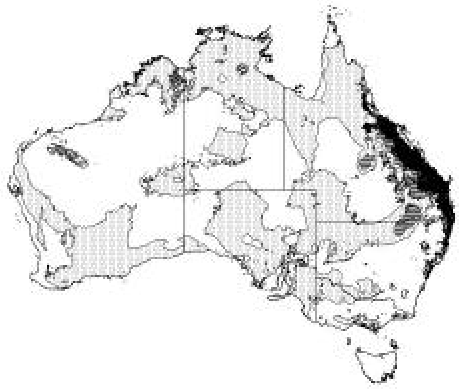

Figure 2d: Predicted distribution for grassowl during spring.

4. DISCUSSION

The overall prediction generated by BIOCLIM, whilst indicative of the range of the species, does not reflect the dynamic nature of the distribution of the grass owl. Customizing BIOCLIM to investigate seasonal variations in distribution proved successful in that a number of new insights were obtained. The changes in the core and irruptive ranges of the grass owl between summer and spring suggest that there may not be separate inland and coastal populations, as was thought previously. These seasonal movements also have important implications for the conservation of the grass owl, as inland areas not evident in the general predictive distribution, may provide ephemeral refugia for the species. Customizing BIOCLIM in a similar manner to investigate other highly moblie species may be a worthwhile exercise.

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