Spotlighting as a reliable method for estimating relative numbers of Northern Greater Gliders (*Petauroides minor*) in eucalypt woodland

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Abstract

Reliability of spotlighting for tracking trends in Northern Greater Glider (*Petauroides minor*) numbers was assessed by repeating three 1-km transects over three consecutive nights, using the same observers and at the same times for each transect, in Blackbraes National Park, north-eastern Queensland. We found that this repeated spotlighting resulted in a method precision of about 25%, based on a coefficient of variation of 25.0. From this finding, we conclude that spotlighting is a sufficiently precise method for monitoring trends in *P. minor* populations under consistent and favourable environmental conditions.

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Introduction

The Greater Glider is the largest of the gliding marsupials and is characterised by having exceptionally bright eye shine. Previously recognised as one species it has recently been split into three species (McGregor *et al.* 2020): the Southern Greater Glider (*Petauroides volans*), Central Greater Glider (*P. armillatus*), and the Northern Greater Glider (*P. minor*, currently classified as Vulnerable both in Queensland and Nationally) which is the subject of this paper. Spotlighting is a recognised technique for detecting nocturnal arboreal mammals, particularly those with bright eyeshine, such as the Greater Gliders (Davey 1990; Lindenmayer *et al.* 2001; Smith & Smith 2018; Emerson *et al.* 2019; Starr *et al.* 2021). Several studies have examined the use of spot-lighting surveys to assess presence or abundance of Greater Gliders. Cripps *et al.* (2021) used double-observer distance sampling to obtain a density estimate of the gliders. Davey (1990) combined spotlighting with trapping to assess a suite of environmental values on several glider species, including the Southern Greater Glider. Goldingay and Sharpe (2004) used both spotlighting and trapping to assess detectability of Squirrel Gliders (*Petaurus norfolcensis*) and concluded there was little difference between the two methods with a detection rate of 25% and 21%, respectively. Emerson *et al.* (2019), using spotlighting, concluded that conventional distance sampling was superior over spotlight surveys along roads or tracks for estimating abundance of Central Greater Gliders. Wintle *et al.* (2005) emphasised the possibility of false negatives where spotlight surveys fail to detect the presence of a target species, such as the Southern Greater Glider. All studies concluded that spotlighting surveys underestimate glider numbers.

Repeat sampling of a transect was made in a number of studies. Lindenmayer *et al.* (2001) assessed the effectiveness of spotlighting in detecting radio-collared individual Southern Greater Gliders. They completed up to seven passes along any one transect per night. However, they pooled their data and found no dependence between passes, which may have been influenced by Southern Greater Gliders actively avoiding the spotlight after five nights (Robinson 1984, quoted in Davey 1990). Kavanagh (1984) repeated transects twice a night, in different directions. Smith and Smith (2018) repeated each transect on three nights but spread over a period of 49 nights.

The only study to compare Greater Glider numbers by repeat spotlighting of transects over consecutive nights, was Robinson's (1984, cited in Davey 1990) sampling over five nights. This study found that Southern Greater Gliders avoided rain and wet conditions, whereas, in non-humid conditions, their activity virtually ceased once temperatures reached 30°C. Robinson also found that Southern Greater Gliders actively avoided the spotlight by the fifth night of the study, and that most activity commenced 60 to 90 minutes after dusk.

The aim of this article is to assess the effectiveness of spotlighting as a measure of trends in the Northern Greater Glider to provide a rigorous method for long-term monitoring of the species on Juntala Plateau. It is based on the efforts of volunteers of the Tree-Kangaroo and Mammal Group (TKMG) and the North Queensland Natural History Group (NQNHG) and will be used as the basis of further articles describing the health of the population over 13 years.

Methods

Locality

Juntala Plateau is a sandstone plateau (elevation 1046–1065 m) in Blackbraes National Park, north-eastern Queensland, centred on 19° 35' 05" S, 144° 02' 35" E (Figs. 1, 2, 3). The climate is a typical monsoon one with cool dry winters and hot wet summers, with a varying length in the intervening dry period, up to 2–3 months with no rain. A signifi-cant population of the Northern Greater Glider was first recorded there in 1984 (Taplin 1984). The population is close to the western extremity of the species' distribution (Fig. 2).

Transects and sampling regime

In 2009, TKMG volunteers commenced spotlight surveys of *P. minor* on Juntala (Russell 2009; Winter 2010). By 2018, they had established 14 1-km transects in cooperation with Queensland Parks

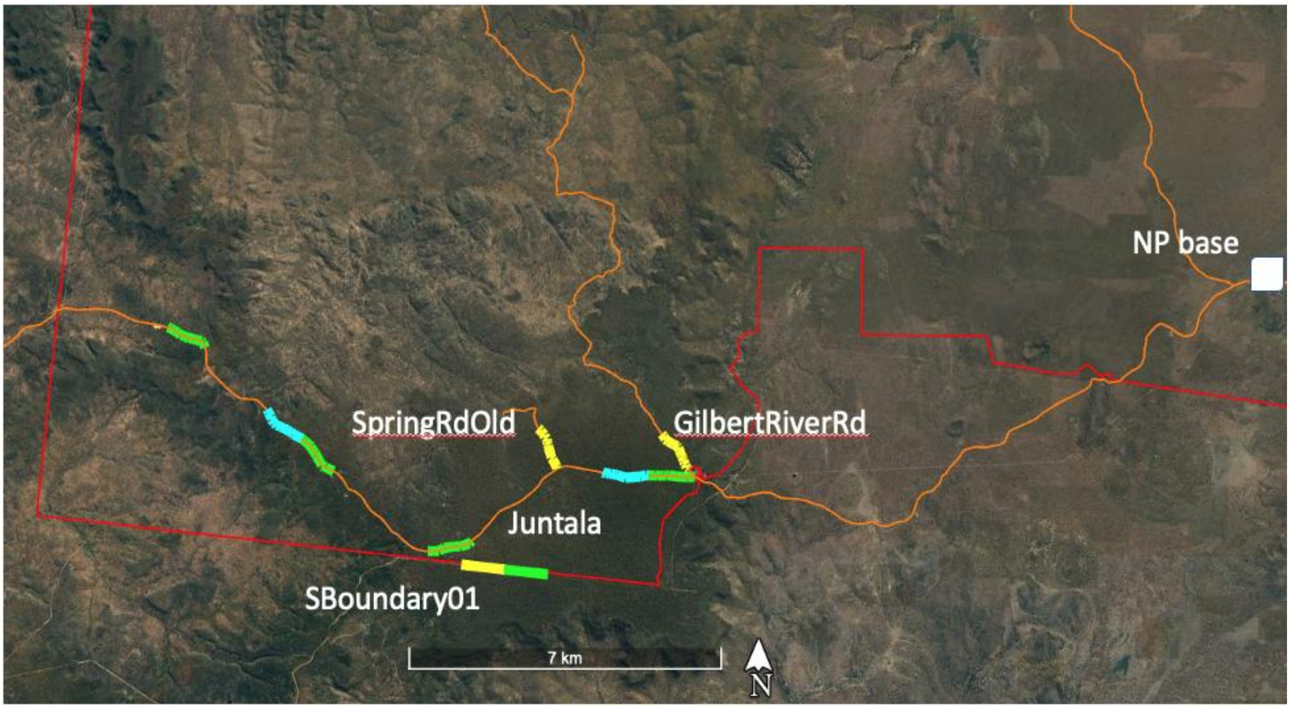

Figure 1. The three sampled transects (yellow) for assessing spotlighting reliability of Northern Greater Glider (*Petauroides minor*) relative abundance on Juntala Plateau, Blackbraes National Park, north-eastern Queensland. Sample transects shown in relation to all ten regularly-sampled 1-km transects.

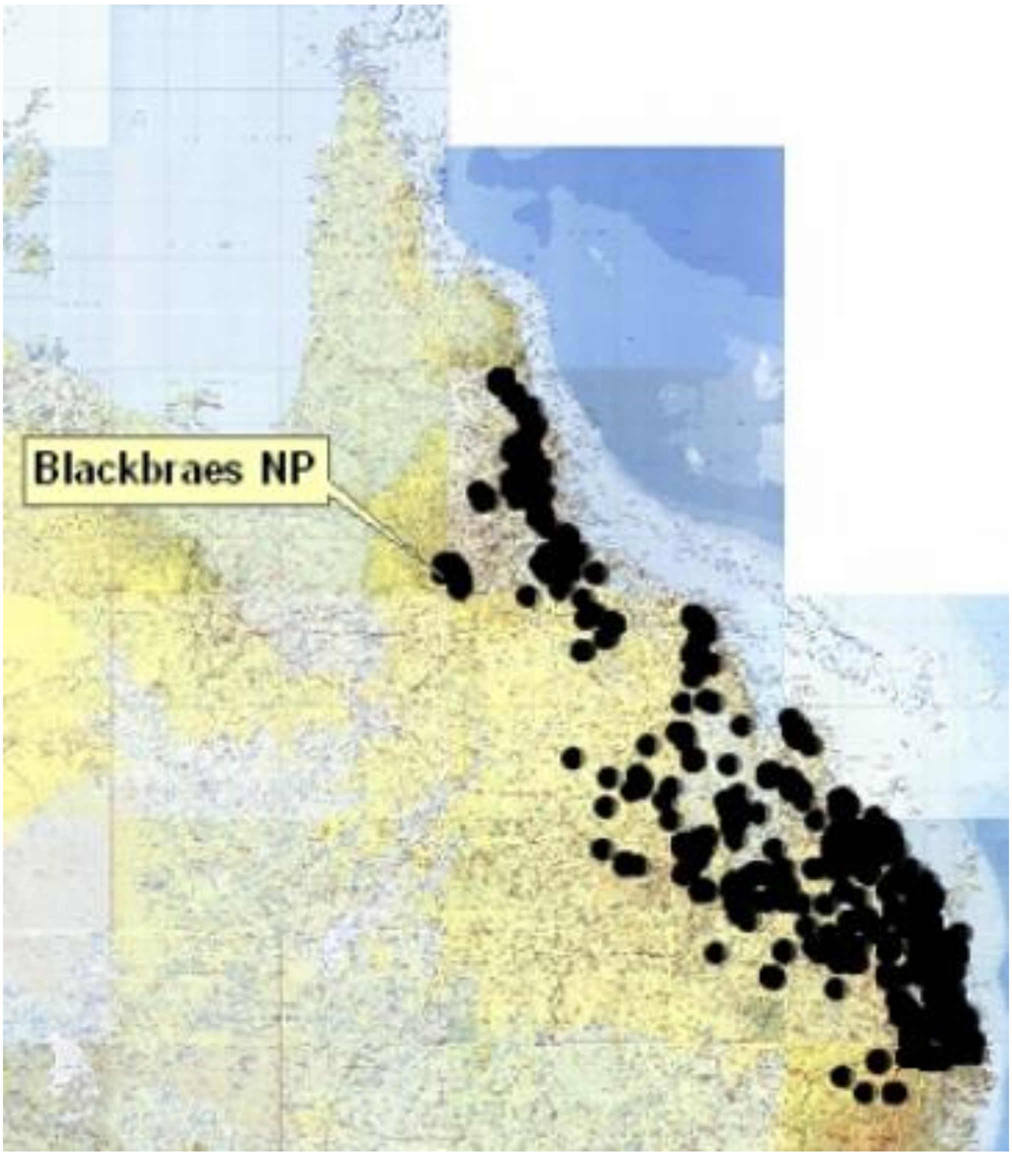

Figure 2. Distribution of Greater Gliders (*Petauroides* spp.) in Queensland showing the most westerly and apparently isolated population in the Blackbraes NP area. Source: Winter (2010).

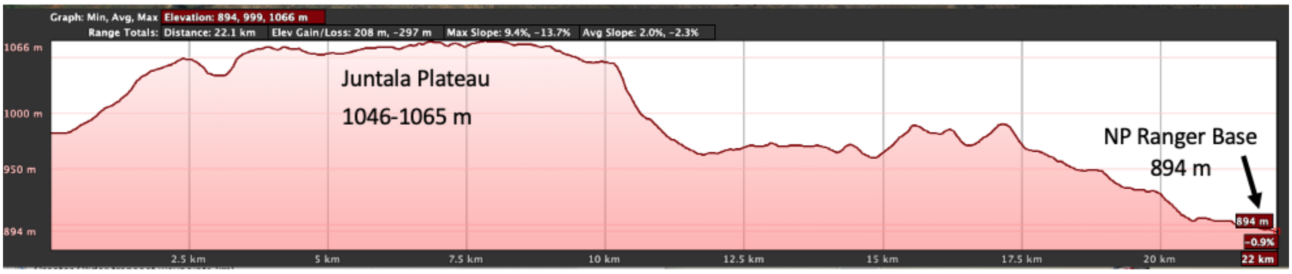

Figure 3. Elevation profile through Juntala Plateau. Source: Google Earth.

and Wildlife Service and Partnerships Rangers. In 2020, a subset of ten transects was chosen for regular sampling towards the end of the dry season (October and November). Since 2022, the sampling has been undertaken by NQNHG. Sampling for the current study was undertaken along three of these transects: SBoundary01, GilbertRRd and SpringRdOld (Fig. 1).

Habitat

All three transects were on soils derived from sandstone. SBoundary01 and GilbertRRd were in very tall eucalypt woodland (30–40 m) with canopy co-dominants of Narrow-leaved Ironbark (*Eucalyptus crebra*) and Lemon-scented Gum (*Corymbia citriodora*), and sparse understorey and shrub layers. The southern 300 m of SpringRdOld was in similar habitat. The remaining 700 m was in tall forest (20–25 m) with co-dominants of *E. crebra* and Yellowjacket (*C. peltata*) and sparse understorey and shrub layers.

Spotlighting

In November 2019, sampling of the gliders was undertaken over three consecutive nights, using two Lightforce spotlights (30 watt, white light) from an open, slow-moving vehicle (< 5 km/h). As Greater Gliders appear impervious to spotlights for up to four consecutive nights (Robinson 1984, cited in Davey 1990), use of three consecutive nights of sampling was not expected to affect the behaviour of the gliders. Each night, spotlighting was undertaken by the same two people, one for each side of the transect, from the same side each time. Travel along the transect was in the same direction each night. Surveying of each transect was undertaken after dark between 19:45 and 21:45, with surveying of each transect starting within 6 minutes each night. Survey duration was between 19 and 24 minutes in all cases. Cloud cover, wind and incidence of rainfall were recorded.

When a Northern Greater Glider was spotted, the following data were recorded: GPS coordinates at the vehicle when it was perpendicular to the glider, time of sighting, tree species, number of gliders in the same tree, estimated height of glider (m) in tree, tree height (m), estimated closest distance (m) from forest edge to the glider.

We used coefficient of variation (CV) for assessing the accuracy of this spotlighting technique fordetecting trends in the Northern Greater Glider population. Coefficient of variation is a measurement of method precision calculated by dividing the standard deviation by the mean (Quinn & Keough 2002). This measurement is useful for comparing means from different populations since it is independent of the unit of measurement.

Results

A total of 78 Northern Greater Glider observations was recorded in the nine surveys, with each transect averaging ~9–10 animals over the three nights (Table 1). For our nine surveys, the overall

Table 1: Repeat sampling of Northern Greater Gliders (*Petauroides minor*) along three 1-km transects over three consecutive nights. Constants throughout sampling period: no moon, wind (Beaufort scale) = 1 still – leaves not moving, temperature approximately 25°C.

Transect name	Date	Time: Start	Time: End	Time: Duration (mins)	Cloud (eighths)	Rain	*Petauroides minor*: no.	*Petauroides minor*: mean ± s.d.	*Petauroides minor*: CV (%)
SBoundary01	25/11/19	19:47	20:10	23	1	none	9	9.0 ± 2.8	31.4
	26/11/19	19:46	20:05	19	8	periodic drizzle	7		
	27/11/19	19:45	20:12	27	7	none	11		
SpringRdOld	25/11/19	20:30	20:54	24	1	none	13	10.3 ± 3.1	29.6
	26/11/19	20:25	20:45	20	8	periodic drizzle	7		
	27/11/19	20:30	20:50	20	3	none	11		
GilbertRRd	25/11/19	21:18	21:43	25	1	none	12	9.7 ± 2.5	26.0
	26/11/19	21:12	21:29	17	8	periodic drizzle	7		
	27/11/19	21:15	21:32	17	1	none	10		
Total				**21 ± 3**				**9.8 ± 2.4**	**25.0**

standard deviation was 2.4, the overall mean number of Greater Gliders was 9.8 and the sample coefficient of variation was 25.0%. Therefore, the expected sampling variation (precision) around the mean number of Greater Gliders observed by spotlighting is likely to be about 25%.

Discussion

We have demonstrated that this spotlighting method provides consistent results for assessing Northern Greater Glider relative population abundance, with a CV of 25%. Our sample size of nine surveys was relatively small – a repeat over three nights along three 1 km transects – but a tripling of transect numbers with the same level of variation would result in only a 1% reduction in CV. We therefore conclude that, given a repeated sampling precision of about 25%, our spotlighting technique is sufficiently robust to compare relative trends of *P. minor* populations. Any population assessment would need to take this level of uncertainty into account. Thus, only population changes substantially greater than 25% should be considered significant when using this method. Moreover, we recognise that spotlighting alone cannot be used to determine population density because it has been shown to significantly underestimate actual population size in *P. volans* (Lindenmayer *et al.* 2001).

As we undertook our surveys on consecutive nights, conditions were fairly similar. However, numbers were consistently least on the second night when 'periodic drizzle' would have increased the wetness of the vegetation. Hence, vegetation 'wetness' may have affected detection rate, as was observed by Robinson (1984, cited in Davey 1990) in the Southern Greater Glider. Greater Gliders are also highly sensitive to temperature (Wagner *et al.* 2020). Robinson (1984, cited in Davey 1990) found that – in non-humid conditions – Southern Greater Glider activity virtually ceases once temperature reaches 30°C. Temperature may also be a factor in the smaller-bodied *P. minor*, although this species may be able to tolerate higher temperatures (Bradley & Deavers 1980; Phillips & Heath 1995). Consequently, our sampling temperatures in the range of 25°C were unlikely to adversely affect detection rate. Hence, variations in environmental conditions may influence the survey results, and efforts should be made to conduct surveys under similar conditions. Consequently, spotlight sampling of *P. minor* is best avoided on wet nights, and should not be undertaken during extreme temperatures.

As well as being reliant on consistent conditions, calculations of long-term trends will rely on consistent methodology. Any variation to our method, such as changes to the number of observers, duration of the surveys, including period of time spent observing and recording each detected animal, or inclusion of other species, or undertaking surveys on foot could all affect the results (Williams 1995). It is always tempting to improve on our spotlighting sampling technique, for example by using the double-observer method (Cripps *et al.* 2021) or thermal imaging (Vinson *et al.* 2020). Hence, long-term monitoring using a suboptimal method applied consistently will give a more accurate result than will be obtained from monitoring regimes in which the methodology is continually 'improved'. A simple methodology such as the one described in this article also has the benefit of being able to be applied by citizen scientists, who may not have access to expensive equipment (or the skill to use it), but have the capacity to collect long-term data that can contribute to our understanding of the natural environment (e.g. Scambler & Burchill 2023). We therefore recommend the use of our simple spotlighting methodology for assessing trends in *P. minor*, with the provisos that it be undertaken during consistent, dry conditions, when temperatures are below 30°C, and that variations in numbers of less than 25% are disregarded.

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