Appendix 2.

Preliminary validation of habitat ranks.

Preliminary validation of the original nectar map for grey-headed flying foxes (Eby and Law 2008)

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BACKGROUND

No suitable data were available for validating the methods and output of the initial flying fox foraging habitat map generated by Eby and Law (2008) at the time the project was completed. This left the outputs of the work, particularly the habitat scores and conservation ranks attributed to vegetation types, open to question. The validity of the habitat ranks assigned to vegetation was contested in some parts of the study area.

Various telemetry and observational studies have documented long-distance movements and feeding patterns of grey-headed flying foxes (e.g. Roberts *et al.* 2012, Tidemann and Nelson 2004) and the potential for using the results of those studies for validating the assessments of habitat quality has been appreciated. However, the number of study animals and the duration of the studies have been too limited to enable comprehensive assessments.

A substantial satellite telemetry study of over 100 grey-headed flying foxes was undertaken in 2012 to comply with Conditions of Approval under the EPBC Act to disperse the flying fox roost from the Royal Botanic Gardens Sydney (J. Martin NSW Office of Environment and Heritage and J. Welbergen University of Western Sydney, unpublished data). Over a five-year period, feeding records of tagged animals were recorded throughout the Eby and Law study area. Jessica Meade and Justin Welbergen of the University of Western Sydney assessed this extensive dataset (>70,000 foraging fixes from 110 study animals) with the aim of providing external validation of the habitat rankings presented in Eby and Law. The approach was to intersect high-quality satellite fixes of foraging grey-headed flying foxes with final habitat ranks and provide a descriptive summary of the results. A summary of this preliminary work is presented here.

METHODS AND RESULTS

Habitat ranks
Eby and Law (2008) identified foraging habitat for grey-headed flying foxes based on the distribution of plant species in its diet, then ranked native vegetation within the range of the species according to the quality of habitat it provides based on the flowering characteristics and distribution of diet species throughout the then range of the animals. The habitat ranks aimed to assist with identifying conservation and management priorities for the species. A key output was shape files of the distribution, characteristics and conservation ranks of vegetation. A complete set of spatial layers and supporting data was made available to this work.

Satellite telemetry data

Movement data from the telemetry study were collected over a 5-year period from 10/05/2012 - 28/04/2017. The number of satellite tracking devices that provided data decreased through time as follows: 2012: n = 97, 2013: n = 64, 2014: n = 27, 2015: n = 14, 2016: n = 7, 2017: n = 2.

All data points (location fixes) acquired from the satellite telemetry study were overlaid with shapefiles of grey-headed flying fox foraging habitat (Eby and Law 2008) and the FINAL_RANK assigned to each polygon was extracted. The Eby and Law project produced a seamless map compiled from numerous smaller vegetation classifications and shape files. In some areas, land that did not contain native vegetation was included in the map and those polygons were assigned final habitat ranks of 0. In other cases, cleared land was omitted from the map. Those areas were considered missing data and assigned 'NA'. Note it was not possible to distinguish between a point outside the range of the Eby and Law map vs a point on a polygon containing an NA value.

The telemetry study generated 100,463 data points. All were overlaid with the Eby and Law spatial layers. Approximately one third of the data points (32,372 points) were located in a polygon identified as containing foraging habitat for flying foxes and assigned a final habitat rank of 1-4. Those points were filtered according to 3 criteria using the following sequential procedure:

1. Time of day – all data points recorded during the night were considered feeding points and were retained (n = 20,812).
2. Spatial accuracy - points with an Argos location class of 1 - 3 were considered of sufficient spatial accuracy for the work and were retained (n = 15,274).
3. Pseudo-replication – points obtained in a single night often occurred as tight clusters of fixes. A single point was selected within each cluster. Initially, points with the most accurate Argos location class were selected, then, if multiple points remained, one point was selected at random (n = 8,769). This procedure accounted for within-cluster pseudo-replication (multiple fixes from the same individual within a single night). Within-individual pseudo-replication (i.e. same individuals visiting the same location repeatedly on separate nights) was not accounted for.

The final dataset comprises 8,769 accurate locations of grey-headed flying foxes in vegetation identified as flying fox feeding habitat in Eby and Law (2008). The points are distributed throughout the Eby and Law study area (Figure 1). The point data were then grouped by the final habitat rank (1-4) assigned to the vegetation type the animal was located in. The distribution of the feeding fixes relative to habitat ranks was summarised based on density (number of datapoints per hectare of habitat) and availability.

Figure 1. (a) The distribution of potential foraging habitat for grey-headed flying foxes (final habitat ranks 1-4) as identified in Eby and Law (2008). (b) The distribution of 8,769 foraging fixes from a satellite telemetry study of 110 flying foxes (2012 – 2017) (Martin and Welbergen unpublished data).

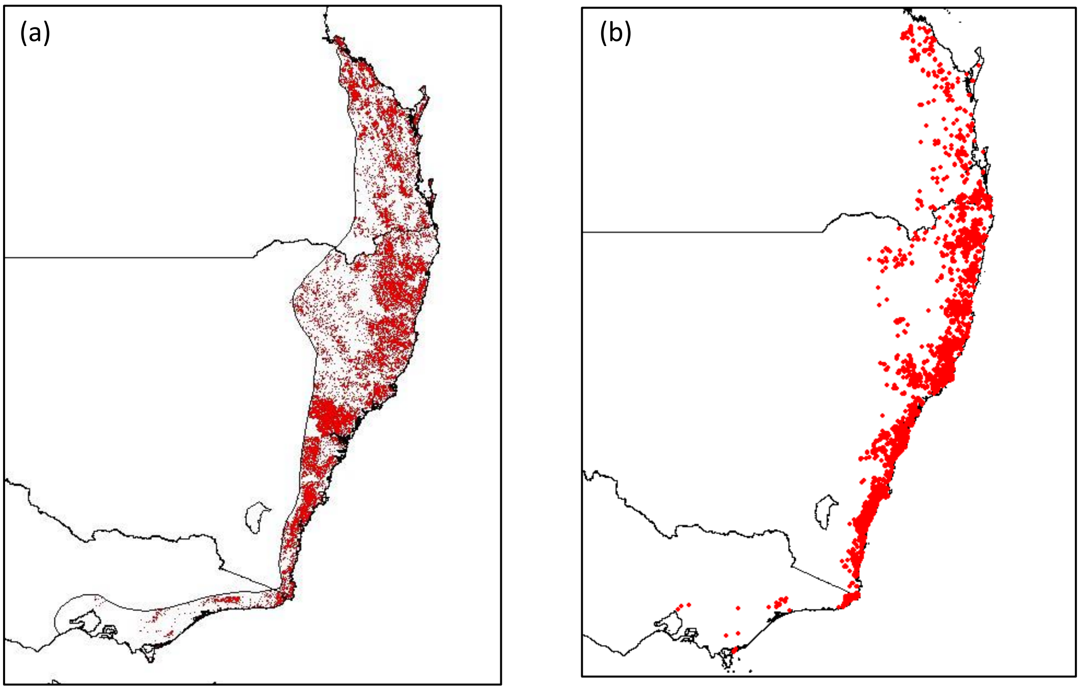


Figure 2. Barplot of the density of foraging points (number of fixes per hectare) within each of the 4 habitat ranks. Rank 1 = highest conservation value, 4 = lowest conservation value. The data show a general trend of increasing presence in habitat of higher conservation value.

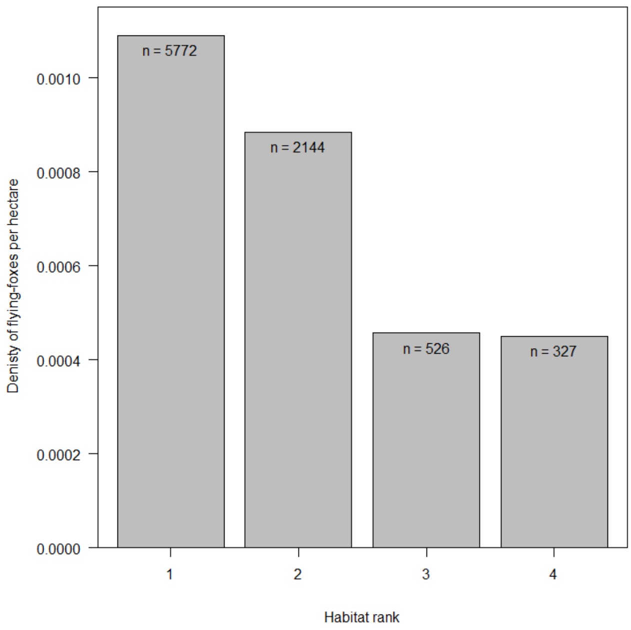
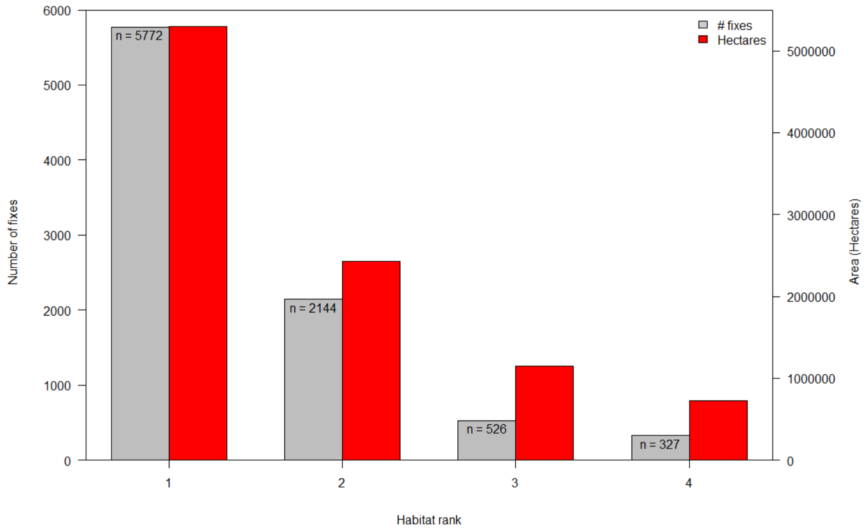


Figure 3. Barplots of the number of individual fixes within each habitat rank, plotted next to the area (areal availability) of each of the four ranks. Scales are standardised on results for habitat rank 1.



CONCLUSIONS

Both summaries of the relationship between foraging locations of grey-headed flying foxes and habitat ranks show the same clear increasing dependence on habitat ranked highly for its conservation value for flying foxes in the Eby and Law project.

The general conclusion is that the analysis of Meade and Welbergen, albeit necessarily based on fairly simple assumptions, provides good support for the preference of grey-headed flying foxes for foraging habitats identified as higher quality (ranks 1 & 2) in Eby and Law (2008). These results support the conclusion that the habitat scores on which the rankings are based reflect the real-world feeding preferences of the animals. They also support the application of the methods of Eby and Law (2008) to the 2019 state-wide flying fox habitat mapping project.

REFERENCES

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