Northern Quoll Monitoring Report

Mount Emerald Wind Farm (2023)

4 elements

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Revision History

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1.0 Summary

The following report presents data from targeted Northern quoll and BioCondition monitoring conducted at two (2) sites within Mount Emerald Wind Farm (MEWF), along with three (3) control sites situated at Walsh River, Brooklyn Reserve, and Davies Creek. This monitoring initiative is conducted to fulfill the conditions outlined in Mount Emerald Wind Farm's Approval under the *Environmental Protection and Biodiversity Conservation Act 1999* (2011/6228) concerning Northern Quoll Management. The methodology complies to the approved Mount Emerald Wind Farm, Northern Quoll Outcomes Strategy, December 2016, R76073/PR130417-2 (Quoll Outcome Strategy).

Non-target data on wild dogs/dingoes, feral cats, and cane toads were also collected via camera traps. Three (3) sampling periods were conducted in 2023, with cameras deployed at each site for a minimum of 14 trap nights. Trapping grids at each site comprised 36 camera survey points, covering 306.25ha at each survey site, with a total of 180 survey points across all sites (1,531.2ha). This report builds upon previous monitoring conducted by the University of the Sunshine Coast (Burnett et al. 2019), which examined whether a similar trend in the number and occupancy of Northern quolls was observed between MEWF and control sites during both construction and wind farm operations. BioCondition sampling was conducted at each site, following the methodology outlined by Burnett et al. (2019). If significant differences in quoll numbers or occupancy were identified between MEWF and control sites, the Quoll Outcome Strategy mandates management actions by MEWF to mitigate impacts and safeguard these populations.

Our analysis revealed a significant interaction between season and treatment, with a notable increase in estimated quoll population numbers during Season 3 at both Mount Emerald sites. However, there were no significant differences in quoll populations or site occupancy between impact and control sites overall. Feral animal populations showed no significant variation between sites. Although we detected a correlation between the presence of feral cats and lower quoll numbers, the low number of feral cat detections means this correlation is not statistically significant. Nonetheless, targeted monitoring and control of feral cats might be necessary to identify and address potential impacts. Despite the presence of abundant toad populations, evidence suggests quolls coexist stably with them. Additionally, vegetation assessments did not show significant differences in vegetation metrics between sites, nor did vegetation have any notable effect on quoll populations.

In summary, the results in this study suggest that the observed patterns in quoll numbers and occupancy at Mount Emerald Wind Farm (MEWF) are consistent across all sites, indicating that the wind farm has had no discernible impact on the local quoll population.

2.0 Introduction

The Mount Emerald Wind Farm (MEWF) is situated approximately 20km SSW of Mareeba on the Atherton Tablelands in North Queensland, at the northern extent of the Herberton Range. Construction of the wind farm concluded in 2019, and it now functions as a generator within the National Electricity Market.

The topography of the northern portion of the project site comprises expansive, undulating hills dissected by ravines and gorges. In contrast, the southern region, situated below the existing 275kV powerline, features rugged and steeply dissected landforms, characterised by narrow ridges and rocky knolls with precipitous slopes. The site encompasses 53 individual wind turbine pads, connected via a network of access roads, some of which accommodate underground cabling. Adjacent to these roads, additional cleared areas were developed to support supplementary cabling requirements. Additionally, a substation and contractors' compound have been established near the centre of the road network on the project site.

The project was granted approval under the *Environmental Protection and Biodiversity Conservation Act 1999* (2011/6228), which included provisions for managing construction and operational activities in areas inhabited by the Northern quoll. Condition 7 of the Approval mandates the maintenance of a viable population of Northern quolls at the wind farm site. The approved monitoring methodology and procedures for implementing adaptive management actions are outlined in the Mount Emerald Wind Farm, Northern Quoll Outcomes Strategy, December 2016, R76073/PR130417-2 (Quoll Outcome Strategy). Monitoring activities have been ongoing throughout the construction and operational phases from 2017 to 2019, overseen by the University of the Sunshine Coast (Burnett et al. 2019). Their research, combined with our own findings from the 2021 quoll monitoring report, revealed no evidence of population changes in quolls over previous survey periods. This 2023 report marks a continuation of the quoll monitoring program, aligning with the stipulations outlined in the Quoll Outcome Strategy.

The Northern quoll (*Dasyurus hallucatus*) is listed as Endangered by both the IUCN and the Australian Federal Government. Extensive population decline and localised extinctions have been observed across much of northeastern Australia (Covacevich and Archer 1975; Burnett 1997; Woinarski et al. 2008). The spread of Cane toads, which are toxic to quolls when ingested, has been a significant factor contributing to their decline. Cane toads first reached southern Cape York around 1980 and had reached the tip of the Cape by 1995, resulting in a sequential decline in quoll populations across Queensland and into the Top End of Australia (Woinarski et al. 2011). Recent estimates suggest a national population decline of over 50% in the last decade, with further losses predicted in the coming decade (Woinarski et al. 2014). However, there are reports of some populations exhibiting signs of toad avoidance in limited areas of North Queensland, as evidenced by field observations documented by the Australian Wildlife Conservancy (unpublished data), Starr et al. (2016), and Starr and Waller (2017) at Brooklyn Station, South Endeavour Station, and Caloola Station, respectively.

In addition to the threat posed by Cane toads, the Northern quoll faces other significant challenges, such as inappropriate fire regimes, which can have detrimental effects on quoll habitat and populations (Andersen 2012). Furthermore, predation by feral cats and wild dogs poses an ongoing threat to quoll survival (Hill and Ward 2010).

The national recovery plan underscores the critical need to safeguard key populations of the Northern quoll across its range (Hill and Ward 2010). Previous research has identified the dry forests on the northern tablelands and the hills and slopes of the MEWF site as vital refuges for this species (Burnett et al. 2013). To better understand possible changes in quoll numbers, earlier monitoring efforts at Mount Emerald monitored key vegetation attributes and the presence of feral carnivores and Cane toads (Burnett et al. 2019). This study spanned six (6) survey periods, assessing trends in individual quolls, modelled population size, and occupancy in comparison to control sites. While seasonal progress reports indicated no significant change in quoll numbers (though some variation in occupancy) or monitored habitat metrics, a final report suggested a potential decline in juvenile quolls and reduced breeding success post-construction, although statistical significance was lacking (Burnett et al. 2019). In our 2021 quoll monitoring report, we observed no significant changes in quoll population or site occupancy across both impact and control sites. Similarly, there were no discernible differences in the numbers of feral animals across the site, nor in the assessed vegetation parameters. This study is a continuation of our previous report, employing similar data collection and analysis methods to evaluate whether populations and habitat variables have remained stable since the construction phase and ongoing site management interventions.

3.0 Methods

Plot-based camera trapping and BioCondition transect assessments were conducted at two (2) impact sites (Mt Emerald 1 and 2) located within the Mount Emerald Wind Farm, along with three (3) nearby control sites (Walsh River, Brooklyn Sanctuary, and Davies Creek). At each site, a 6 x 6 camera trap station grid was established, with traps spaced 350m apart as per the specifications outlined in the Quoll Outcome Strategy. This resulted in 36 survey points per site, covering an area of 306.25ha per survey site, and a total of 180 survey points overall (1,531.25 ha).

3.1 Camera Trapping

Camera traps were deployed and baited at each survey point to collect data on Northern quolls for capture-recapture and site occupancy analysis. Additionally, data on Dingo/Wild dog (*Canis familiaris*), Feral cat (*Felis catus*), Feral pig (*Sus scrofa*), and Cane toad (*Rhinella marina*) were collected to assess their relative abundance. However, it is important to note that camera traps may not be the most ideal tool for accurately monitoring some of these species.

RECONYX Hyperfire® (HC550 and HP2W) and Bolyguard® (SG 562-C and 2060-D) camera traps were utilised at each sample location. Cameras were mounted horizontally on a picket or tree trunk, positioned 150cm above the bait station, and aimed perpendicular to the ground as shown in **Plate 1**, following the methodology from previous sampling periods (Burnett et al. 2019). The bait cannister consisted of a PVC plumbing tube secured at each end with a plumbing cap and ventilation cowl, baited with chicken necks to attract quolls to the camera station. The location of survey sites is depicted in **Figure 1**. Three (3) sampling periods were conducted at each site in 2023 (**Table 1**), with camera traps deployed for a minimum of 14 trap nights per period, operating continuously for 24 hours and capturing three (3) images per event.

Plate 1. Camera positioned to capture quolls at the bait station, providing clear horizontal images showcasing individual markings.

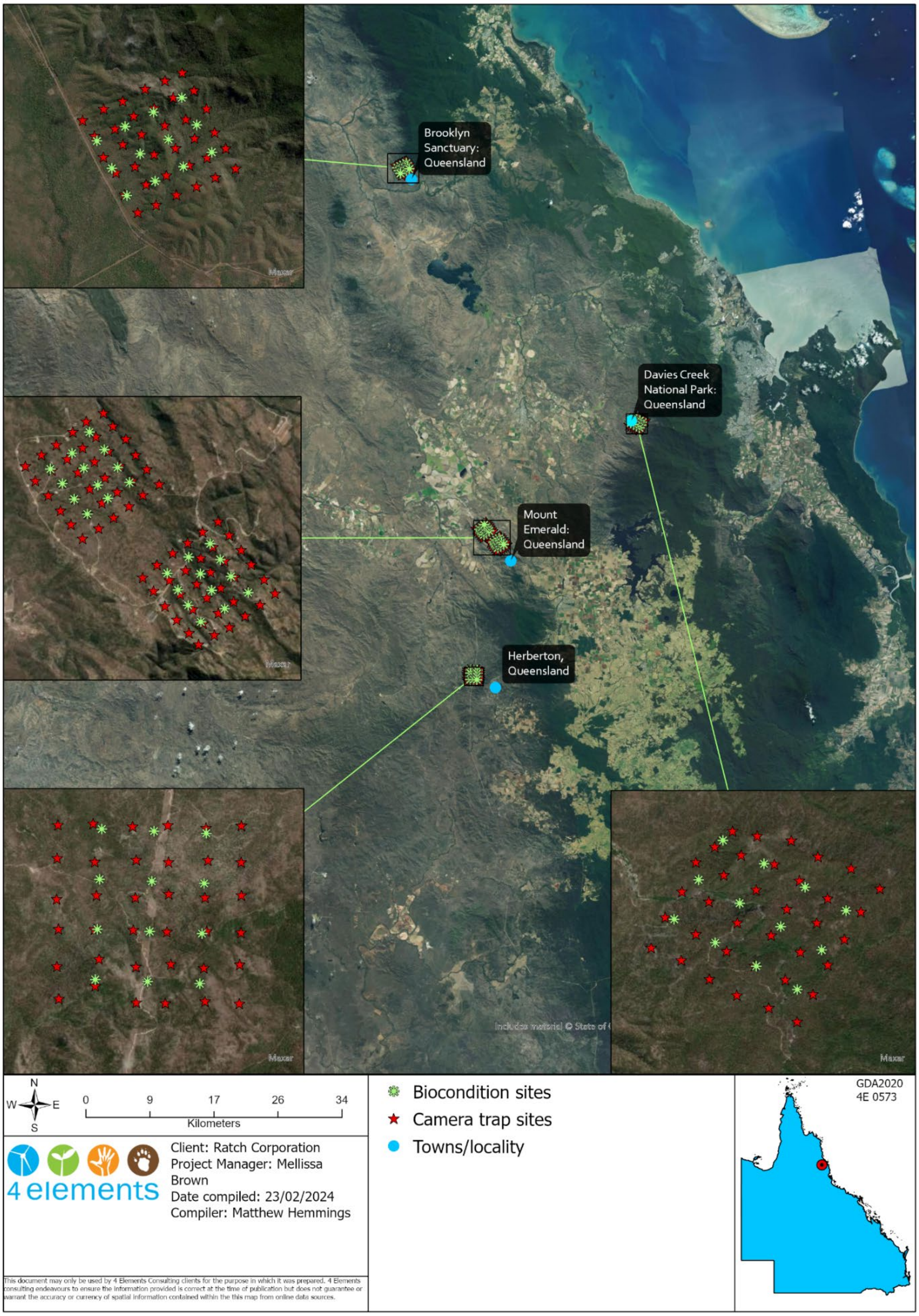

Figure 1 Location of Camera Trapping Stations and BioCondition Assessment Plots

Table 1 Site Locations and Survey Periods

Site	Type	Monitoring dates		
		Survey 1	Survey 2	Survey 3
Mt Emerald 1	Impact	20/02/23 - 08/03/23	04/7/23 - 18/07/23	01/11/23 - 17/11/23
Mt Emerald 2	Impact	21/02/23 - 10/03/23	05/7/23 - 21/07/23	20/11/23 - 05/12/23
Brooklyn Sanctuary	Control	28/02/23 - 16/03/23	13/7/23 - 01/08/23	09/10/23 - 24/10/23
Davies Creek	Control	20/03/23 - 06/04/23	28/7/23 - 11/08/23	31/10/23 - 14/11/23
Walsh River	Control	22/03/23 - 05/04/23	14/8/23 - 30/08/23	26/10/23 - 10/11/23

3.2 BioCondition Assessments

The habitat census utilised a modified BioCondition method (Burnett et al. 2019), initially devised by Eyre et al. (2011). The adaptation involved expanding the woody debris plot dimensions to 100 x 20m, previously set at 50 x 20m. Surveys were conducted using a twelve-point grid, strategically positioned within the camera trapping grid to cover the diverse vegetation structure characteristic of each survey site (**Figure 1**).

3.3 Data Analysis

3.3.1 Fauna Data

All images were tagged in EXIF PRO® by species and individual, and the data were subsequently analysed using *camptrapR* (Niedballa et al. 2017) within the R statistical environment (R Core Team 2016). Prior to analysis, the time and date accuracy of each image was verified and corrected if necessary. To obtain the minimum number known to be alive, Northern quolls were individually identified based on their natural spot markings. These individuals were cross-checked across seasons to account for recaptures. For estimating occupancy and population size, the total number of quoll detections at each site during each season was utilised. However, identifications were restricted to within each season, meaning quolls observed in multiple seasons were treated as separate observations in each respective season. Non-target species were not identifiable at the individual level but was considered a distinct observation after a 15-minute interval.

Following the methodology outlined by Burnett et al. (2019), Northern quolls at each site and sample period were assessed using the following analyses:

- Minimum number known to be alive (KTBA): The number of unique individuals photographed and identified in each of the sampling period, with recaptures across seasons accounted for.
- Population size estimation using the R-package *RMARK*.
- Naïve occupancy: The number of camera trap stations where quolls were detected, expressed as a proportion of all stations.

- Occupancy estimate generated using the R-package *unmarked* (Fiske 2011).

3.3.2 Habitat Metrics

Vegetation sampling followed the methodology outlined by Burnett et al. (2019), utilising a modified BioCondition assessment. This involved recording the following parameters:

- Coarse woody debris within 100 x 20m plots.
- Species richness of trees, shrubs, grasses, and forbs.
- Average percent of vegetation ground cover across five 1m^2 quadrats spaced 10m apart along a 100m transect. Data included native perennial and annual grass cover, native forbs, native shrubs (‹1m height), non-native grasses, non-native forbs, litter, rocks, and cryptograms.
- Shrub (>1m height) and canopy cover along the 100m transect.

4.0 Results

4.1 Quoll Populations

Throughout the sampling period, which totalled approximately 7560 camera trap days (504 per site, per season), a total of 445 instances of quoll presence were recorded. These observations included 150 individual quolls (**Table 2**). Occupancy varied among sites, ranging from 7 to 55 individuals, with the lowest count recorded in Walsh River and the highest in Davies Creek. The Mt Emerald sites fall within the lower to mid-range of values, with 16 individual quolls detected at Mt Emerald 1 and 23 at Mt Emerald 2. Population sizes across the sites were estimated using Bayesian estimation and minimum number of quolls known to be alive at each site during each season, as illustrated in **Figure 2**. There was no significant difference in estimated quoll populations among the seasons ($F_{2,540}$ = 0.004, p = 0.99), and no effect of treatment was observed ($F_{1,3}$ = 1.07, p = 0.38); however, there was a significant interaction between sample and treatment, with a noticeable increase in estimated population size in season 3 for both the Mt Emerald sites.

Table 2 Minimum number of Northern quolls known to be alive across all sites and seasons

	Season 1	Season 2	Season 3	Total
Brooklyn	19	20	14	**49**
Davies Creek	21	23	19	**55**
Mount Emerald 1	7	3	6	**16**
Mount Emerald 2	6	12	7	**23**
Walsh River	5	3	1	**7**
Total				**150**

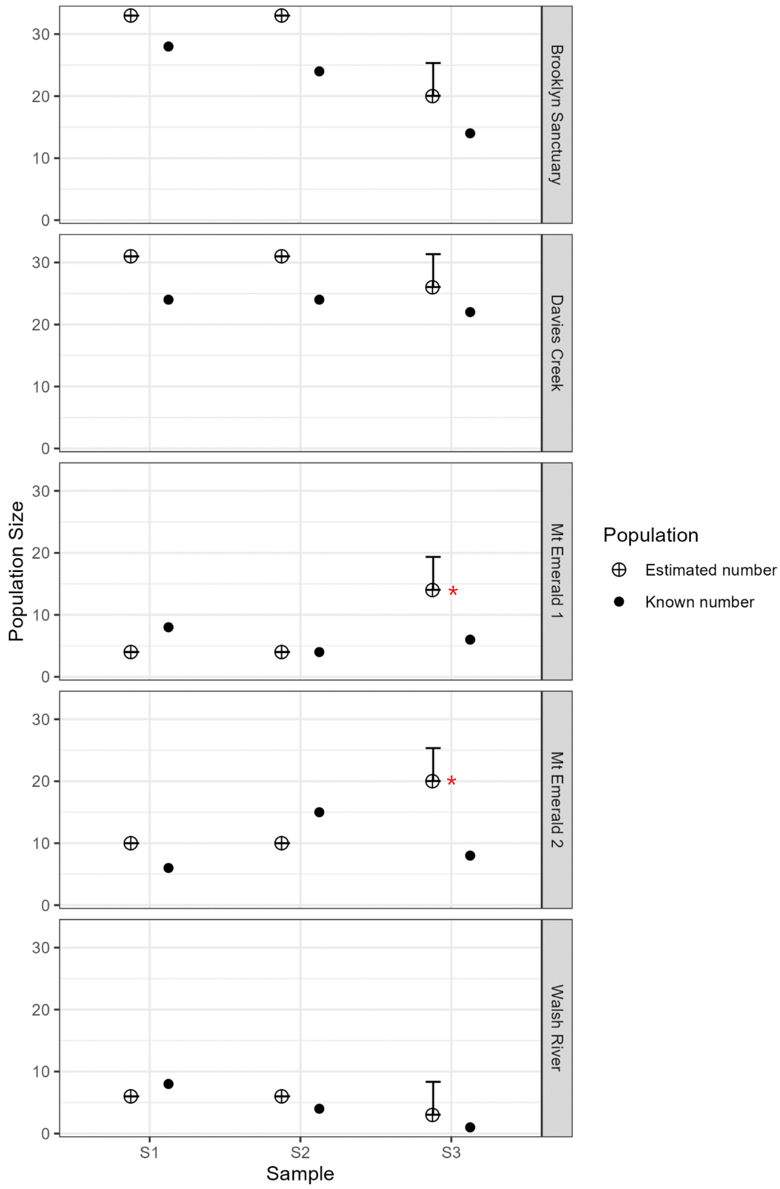

Figure 2 Estimated population sizes with asymmetric standard deviation estimates using Bayesian estimation and total number of Northern quolls detections at each site during each season, calculated using the R package RMARK. The asterisk (*) denotes significance, indicating that the effect of treatment varies depending on the sampling period ($F_{2,540}$ = 7.14, p < .001).

Naïve occupancy rates, representing the proportion of cameras detecting quolls, varied across sites and sampling periods, ranging from 0.11 in Walsh River to 0.67 in Davies Creek. The Generalised Linear Mixed Model (GLMM) was used to assess the impact of treatment on quoll occupancy, with no significant effects observed for treatment or season (all p > .05). **Figure 3** illustrates the observed occupancy rates across the different sites and seasons, while **Figure 4** presents both the observed and predicted site occupancy rates using the Bayesian occupancy method. This method considers the possibility of quolls being missed in the total observed count, accounting for potential errors.

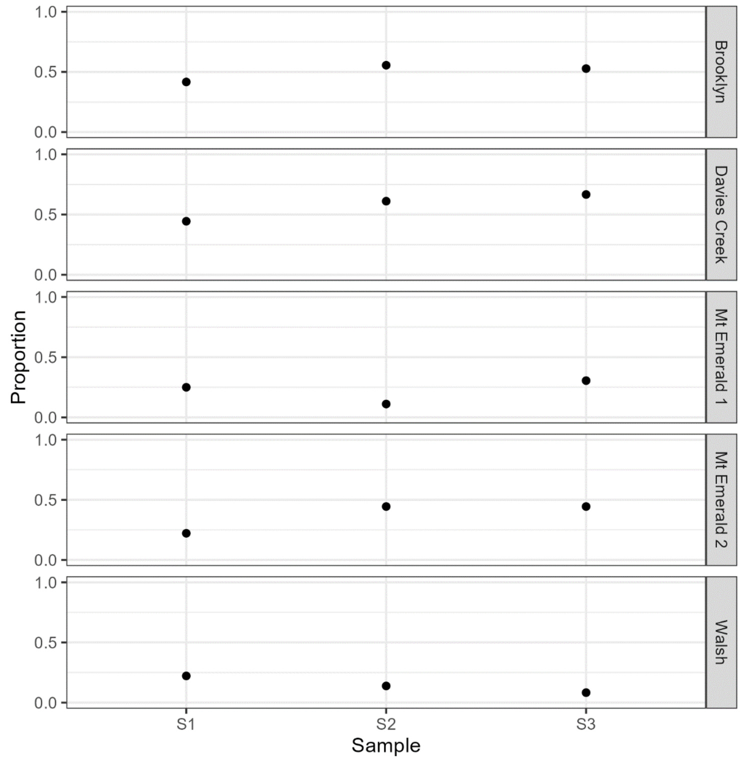

Figure 3 Naïve occupancy rate by Northern quoll across all sites and seasons. The highest occupancy rate were observed at Davies Creek during season 3 (0.67) and the lowest in Walsh River during season 3 (0.08). No significance was found between treatment sites and control sites.

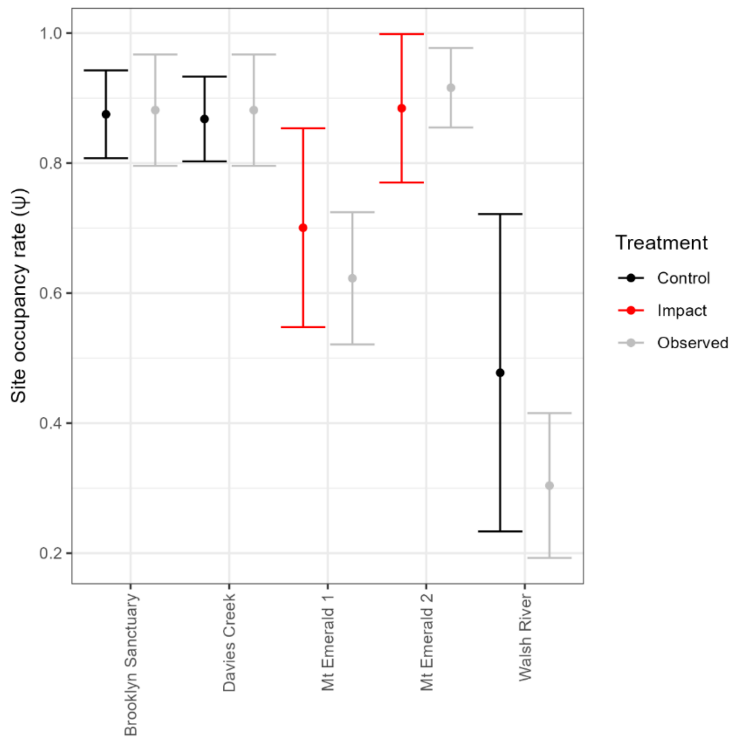

Figure 4 Observed (grey) and predicted (Bayesian method, black/red) site occupancy rate, representing the proportion of sites where quolls were observed or predicted to occur using the R package unmarked. The data were not sampled by season (S1, S2, S3) due to insufficient data for constructing meaningful error bars at that resolution.

4.2 Feral animals

No discernible impact of treatment on feral animal populations was observed in this study, indicating that feral animal numbers remained consistent between the impact and control sites. **Figure 5** presents the recorded numbers of each pest species throughout the study period. Feral cats were only detected at the Walsh River control site and the two treatment sites on Mt Emerald. While the data suggest a moderate negative correlation between the presence of cats and lower quoll populations, the scarcity of cat data (totalling 8 across all sites and seasons) precludes reliable statistical analysis (**Figure 6**).

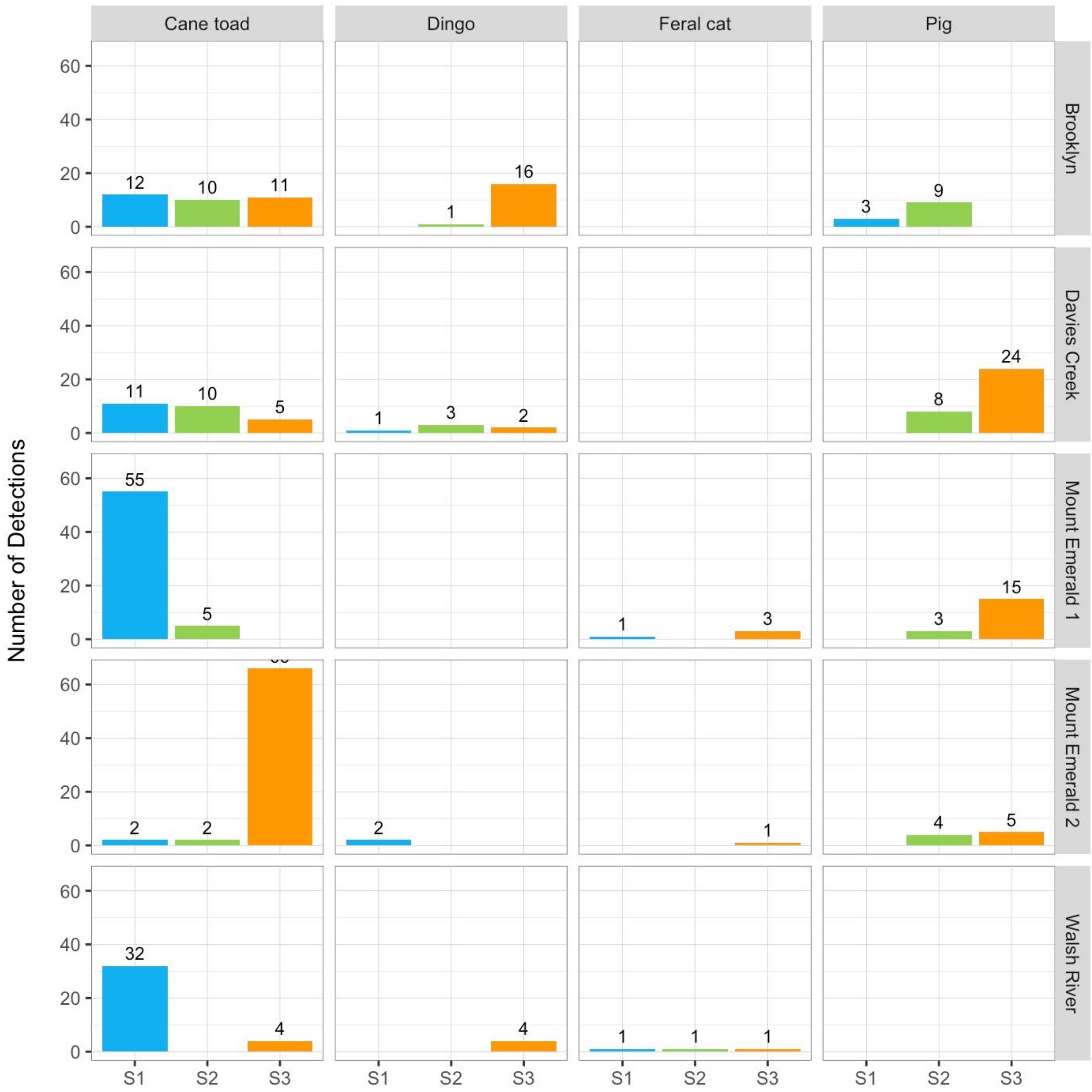

Figure 5 **Frequency of detections for non-targeted feral species across each site and season. The numbers above each bar denote the count of detections for each species at the respective site and season.**

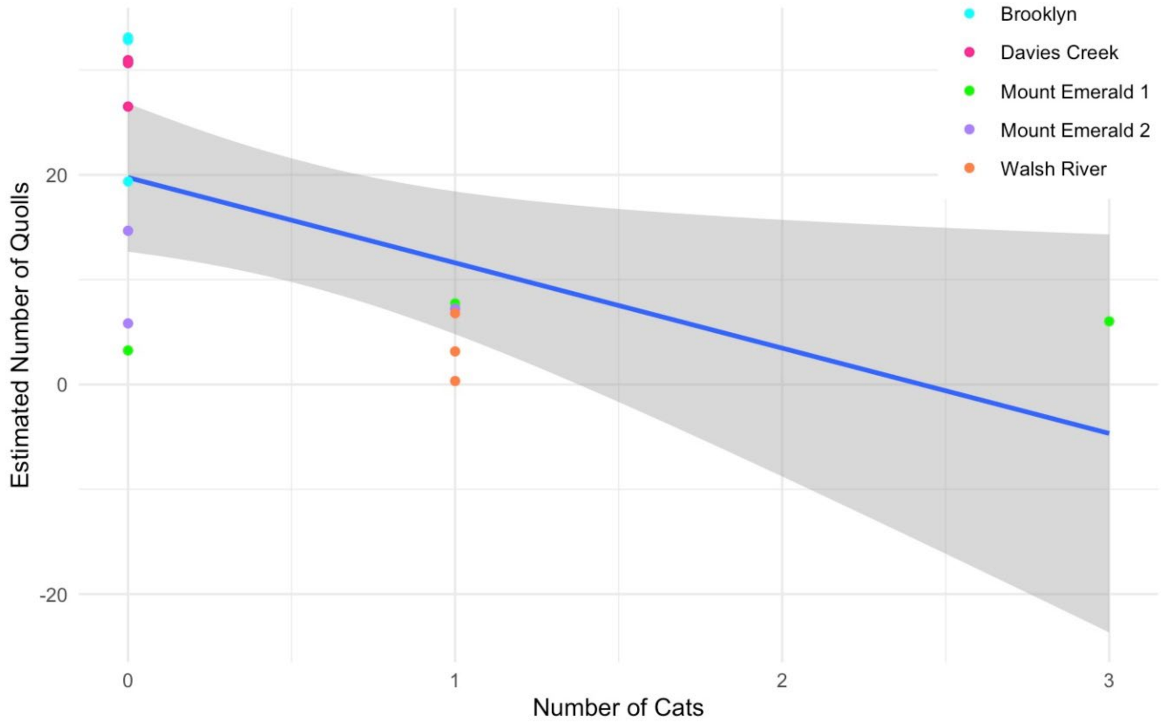

Figure 6 Relationship between the predicted number of quolls and the number of cat observations across all sites and seasons (r^2 = 0.307). Each point represents a unique combination of site and season. The smooth line depicts the linear model fit, accompanied by a 95% confidence interval.

4.3 Changes in Habitat

A multi-factor analysis was undertaken to determine whether any of the 19 vegetation variables enabled site differentiation, with the first two factors explaining approximately 20% of the variation. However, no consistent pattern emerged from the analysis (**Figure 7**). Subsequently, the scores derived from these two dimensions were utilised as predictors to assess if vegetation and seasonal factors influenced quoll population size. The predictors encompassed the covariance of leaf litter, canopy cover, and large Eucalypt and non-Eucalypt trees. The analysis revealed no discernible impact of vegetation or season on quoll population size (**Table 3**). The vegetative habitat metrics are illustrated in **Figure 8**.

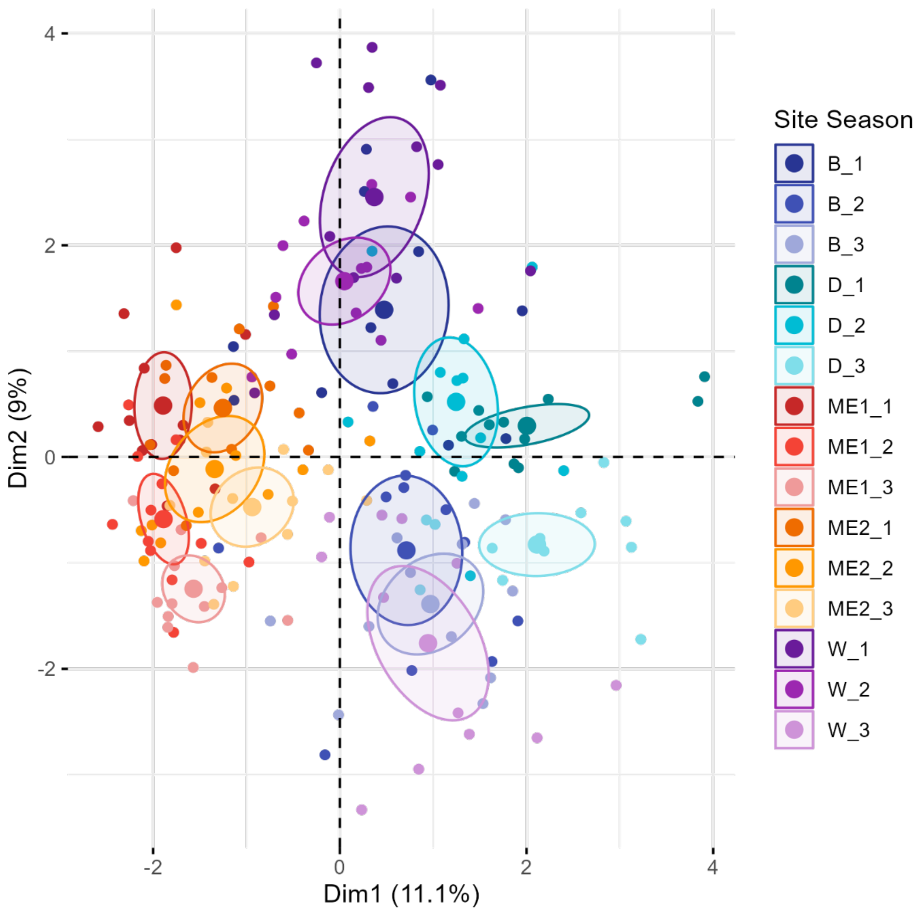

Figure 7 Relationship between vegetation variables and site separation across seasons. Warm colours denote impact sites, while cool colours represent control sites, with colour density indicating the season. Each point represents a vegetation survey and ellipse represents the 95% confidence interval per site and season.

Table 3 Vegetation Attributes and Quoll Population Size

	DF	Sum of Squares	Mean Squares	F value	p-value
Season	2	386.13	193.07	0.66	0.55
PCA1	1	127.5	127.95	0.44	0.53
PCA2	1	77.70	77.70	0.26	0.53
Season:PCA1	2	411.19	205.56	0.70	0.53
Season:PCA2	2	52.30	26.15	0.09	0.92
Residuals	6	1761.66	293.61		

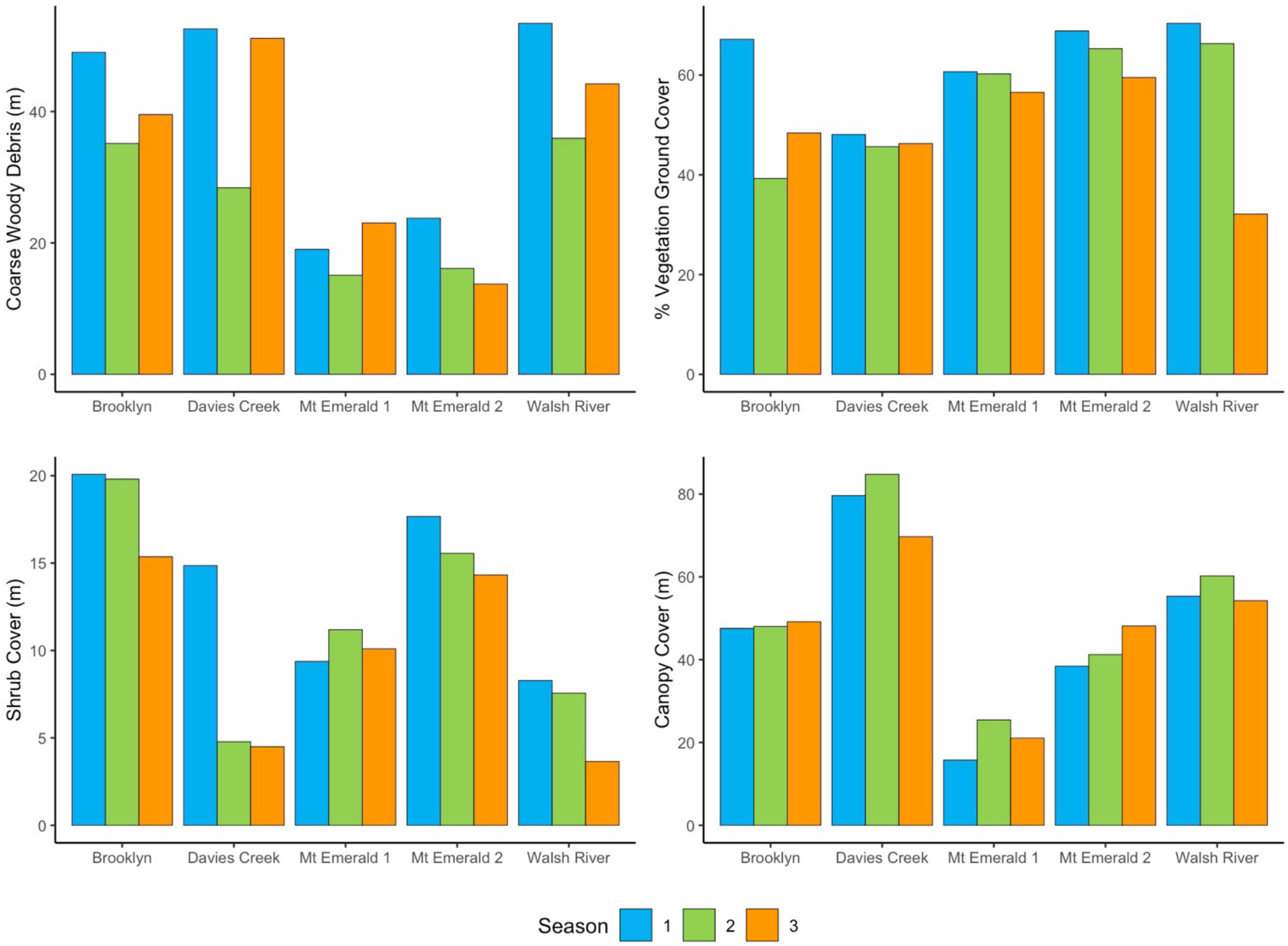

Figure 8 Mean vegetation habitat metrics across all sites and seasons. Coarse woody debris, shrub (>1m height), and canopy (including subcanopy) cover collected along a 100m transect. Percentage vegetation ground cover collected across five 1m^2 quadrats spaced 10m apart along a 100m transect. Vegetation ground cover include native perennial and annual grass, native forbs, native shrubs (<1m height), non-native grasses, and non-native forbs.

5.0 Discussion

The dataset presented herein reveals no significant disparity in Northern quoll populations or site occupancy between impact and control sites. However, a significant interaction between season and treatment was observed, with a notable increase in estimated population numbers during season 3 at both Mount Emerald sites. Spanning three seasons over the course of a year, this study alone was not designed to detect long-term temporal shifts in quoll populations at the Mount Emerald Wind Farm (MEWF). Comparisons with our previous 2021 report and earlier studies conducted between 2017 and 2019 (Burnett et al. 2019) suggest that neither the estimated population numbers nor the occupancy of quolls at Mount Emerald 1 or 2 have exhibited declines. Although some variations exist between the analyses conducted in this report and those performed by Burnett et al. (2019), a comprehensive reassessment of the entire dataset spanning from 2017 to 2023 would be necessary to ascertain any statistically significant changes. The absence of reported declines in occupancy noted in the 2021 report persists in this 2023 iteration, contrasting with earlier findings by Burnett et al. (2019) that may be attributed to the initial construction activities influencing quoll habitat utilisation patterns.

Feral animal populations, including cats, toads, dogs, and pigs, exhibited no significant differences between impact and control sites, suggesting minimal impact from the wind farm on the abundance of these species. However, it is worth noting that the data on feral species were opportunistically collected using camera traps and lack species-specific methodologies, necessitating more targeted surveys for precise analyses. Feral cats were exclusively detected at the Walsh and Mount Emerald sites, consistent with prior studies (Burnett et al. 2019), and while limited cat data were available, a potential correlation was observed between cat presence and reduced quoll numbers. Given that camera traps tend to underestimate feral cat abundance, targeted monitoring and control efforts are imperative for obtaining more accurate data.

Furthermore, despite their abundance in the surveyed area, toads are unlikely to adversely affect quoll populations, as they have coexisted for generations. However, discrete detections of toads near bait canisters, potentially skewing detection frequencies, warrant further investigation through marked individual identification studies. Parameters assessing vegetation condition and structure revealed no notable discrepancies between control and wind farm sites, suggesting insufficient differences to significantly influence Northern quoll population estimates.

In summary, the data indicate consistent Northern quoll numbers and occupancy across all sites, with feral cats potentially emerging as the primary threat to populations at the wind farm. Continued control and monitoring of this pest species may enhance protection for the Mount Emerald Northern quoll population. As stipulated by the Quoll Outcome Strategy, further monitoring is scheduled for 2028. This future monitoring will enable us to compare long-term population changes between the years 2021 and 2028, providing valuable insights into the population dynamics and the effectiveness of conservation efforts over time.

6.0 Acknowledgements

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