

Biology Report 2023

The effect of soil moisture on the abundance of eucalypt species.

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1.0 Rationale

Eucalyptus is a diverse genus of flowering trees and shrubs native to Australia, comprising over 700 species. These species are cultivated worldwide for both ornamental and commercial purposes, particularly in timber and paper production. Eucalypts prefer well-drained soils with adequate moisture, and many have distinctive features such as aromatic foliage, peeling bark, and small white or cream-colored flowers. Their leaves are also used to extract essential oils applied in aromatherapy, perfumes, and medicine (Eucalyptus | Description, Major Species, & Uses, n.d.).

Dry sclerophyll forests, which develop in regions with low to moderate rainfall, are dominated by Eucalyptus species and support a range of grasses and shrubs in the understory. Canopies in these forests typically range from 25 to 35 metres in height and are moderately dense, often interconnecting to create a continuous canopy layer (Dry Sclerophyll Forests (Shrubby Sub-formation) | NSW Environment, Energy and Science, n.d.).

Soil moisture is a key abiotic factor that influences plant growth and distribution. Soil moisture is expressed as a percentage of water content relative to solids in a soil sample and is critical for plant survival, nutrient uptake, and physiological processes (Soil Moisture, 2015). Understanding the relationship between soil moisture and the abundance of Eucalyptus species can provide insight into their ecological adaptations and distribution patterns.



2.0 Research Question

How does soil moisture influence the abundance of *Eucalyptus globulus* in a dry sclerophyll forest at Whites Hill Reserve?

3.0 Original Experiment

The methodology for this investigation was adapted from:

Sharen. (2022, November 16). *TFEEC School Data 2020-21*. Onenote. Retrieved February 23, 2023, from https://qedu-my.sharepoint.com/personal/swyte0_eq_edu_au/_layouts/15/Doc.aspx?sourcedoc={8e7e2b14-a051-4b94-9ed2-08866c72e8db}&action=view&wd=target%28_Content%20Library%2FIA2.one%7C67f4e300-cc72-4d4d-880b-7dbdffa8e7d3%2FIA2%20Prep%7C3833c4b0-f71b-4a37-85c2-4c6540f019fe%2F%29&wdorigin=NavigationUrl

The original experiment was conducted in Toohey Forest, investigating the effect of soil moisture on plant species abundance in a dry sclerophyll forest. A 70-meter transect line and 10 × 10 m quadrats were used to collect data on plant distribution and abundance.

4.0 Modifications to the Methodology

Refinements:

The study focused specifically on the abundance of Eucalyptus species, measured within 10 × 10 m quadrats. To reduce variability, other abiotic factors such as temperature, soil pH, and canopy cover were held constant. Nine quadrats were distributed across three transect lines at varying distances from the water source, ensuring a representative sampling of soil moisture conditions.

Extensions:

The experiment controlled for variables including distance from the creek and temperature (average 18–26°C) to increase reliability and validity. Data collection concentrated solely on Eucalyptus species abundance, rather than multiple plant species, to provide clearer insights into the relationship between soil moisture and species distribution.

Refinements included:

- Measuring only Eucalyptus species abundance.
- Shortening transect distance to 10–60 m from the creek.
- Conducting the experiment at Whites Hill Reserve, a habitat favorable to Eucalyptus growth.

Extensions included:

- Using multiple quadrats per transect line to increase data accuracy.
- Focusing on Eucalyptus species to refine analysis and reduce confounding variables.

5.0 Risk Assessment

Risks:	Hazards:	First Aid:
Environmental damage from trampling over plants	Trampling over plants	Avoid trampling sensitive areas
Exposure to plants with thorns, stings or poison	Thorns, stings, or toxic species	Wear protective clothing; wash skin; seek medical attention if severe
Insects	Bites or stings	Use insect repellent; treat bites; seek medical help if allergic reaction
Tripping	Uneven terrain	Walk carefully, use RICE for minor injuries; seek medical care if needed
Weather	Hypothermia, heat exhaustion, sunburn	Wear appropriate clothing, apply sunscreen, hydrate, seek help if severe

6.0 Presentation of data

For the analysis of this experiment, the following data processing occurred:

- The mean was used to analyse the experiment data and counteract anomalies. This was done with the formula below.

$$\bar{X} = \frac{\sum X}{N}$$

- Standard deviation was used to calculate the standard error using the provided formula.

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

- This formula calculated the standard error of the mean to show uncertainty in soil moisture and eucalyptus species abundance at different distances from the creek.

$$SEM = \frac{s}{\sqrt{n}}$$

Table 1: Sample calculations

Calculations	Example
Mean	The mean for Quadrat 1 (10 – 20m for transects line 1,2 and 3) for example was: $1+2+2 \div 3 = 1.666666667$
Standard deviation (STD)	Standard deviation (SD) was calculated in Excel using the STDEV.P function for the three transect lines abundance data recorded. Quadrat 1 (10-20m) for all three transect lines was SD = 0.4714
Standard error of Mean	The standard error of the mean for Quadrat 1 (10-20m for transects line 1,2 and 3) was calculated using the formula $SEM = s/\sqrt{n}$ Where SEM is the standard error of the mean s is the sample standard deviation n is the sample size (number of scores). The value for SEM was 0.272165527 calculated as $SEM = 0.471404521/\sqrt{3}$.

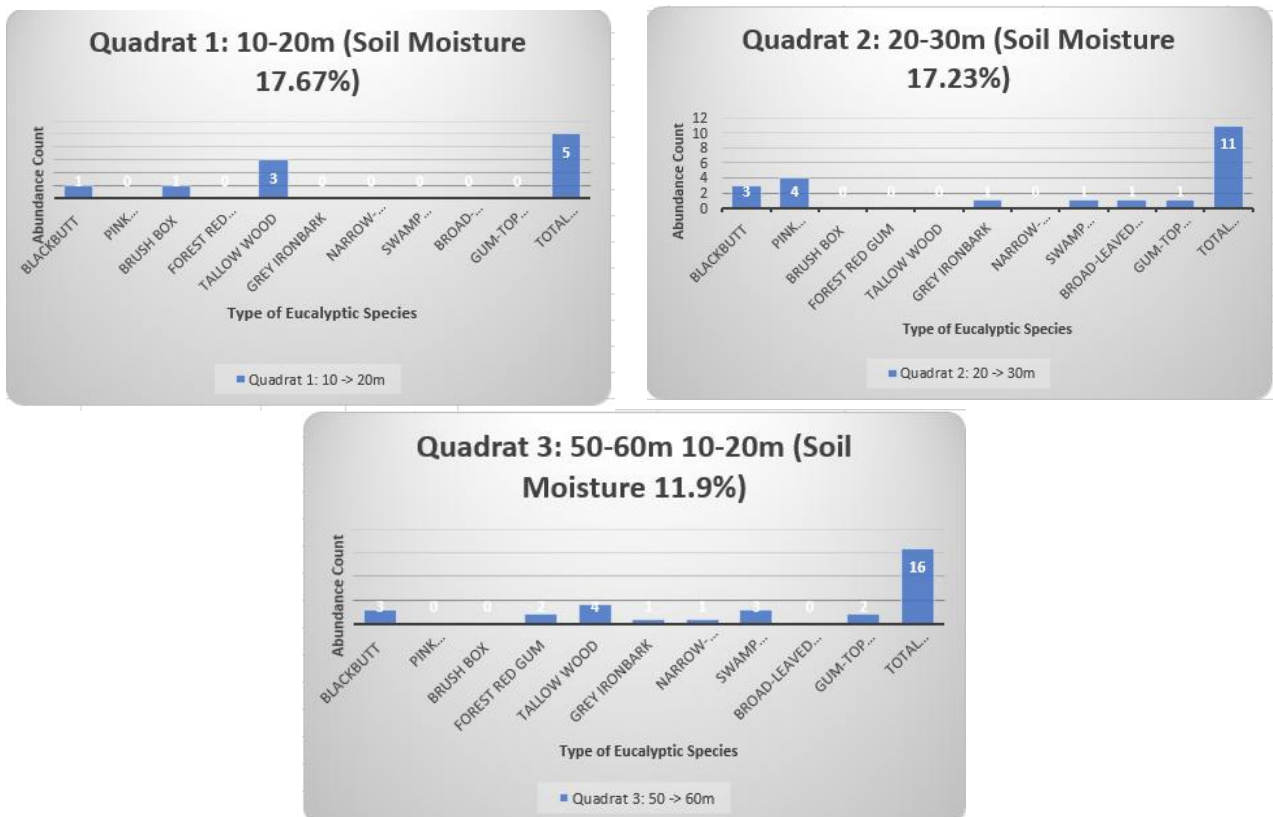
Table 2: Abundance of Eucalyptus Species

Transect line No.	Processed Table		
	Quadrat 1 (10m -> 20m)	Quadrat 2 (20m -> 30m)	Quadrat 3 (50m ->60m)
#1	1	4	5
#2	2	5	7
#3	2	2	4
Total Abundance	5	11	16
Average (Mean)	1.67	3.67	5.33
Standard Deviation	0.47	1.25	1.25
Standard Error of the mean	0.27	0.72	0.72
P-Values	0.05		

Interpretation:

Quadrat 3 had the highest abundance (16 trees) and diversity. Variations in SD and SEM indicate that data points were mostly consistent, with Quadrat 3 being slightly more variable. A p-value of 0.05 suggests a significant difference in Eucalyptus abundance between quadrats, supporting previous studies on species preference for lower soil moisture.

Figure 1: Mean Abundance of Eucalyptus Species for Quadrats 1–3



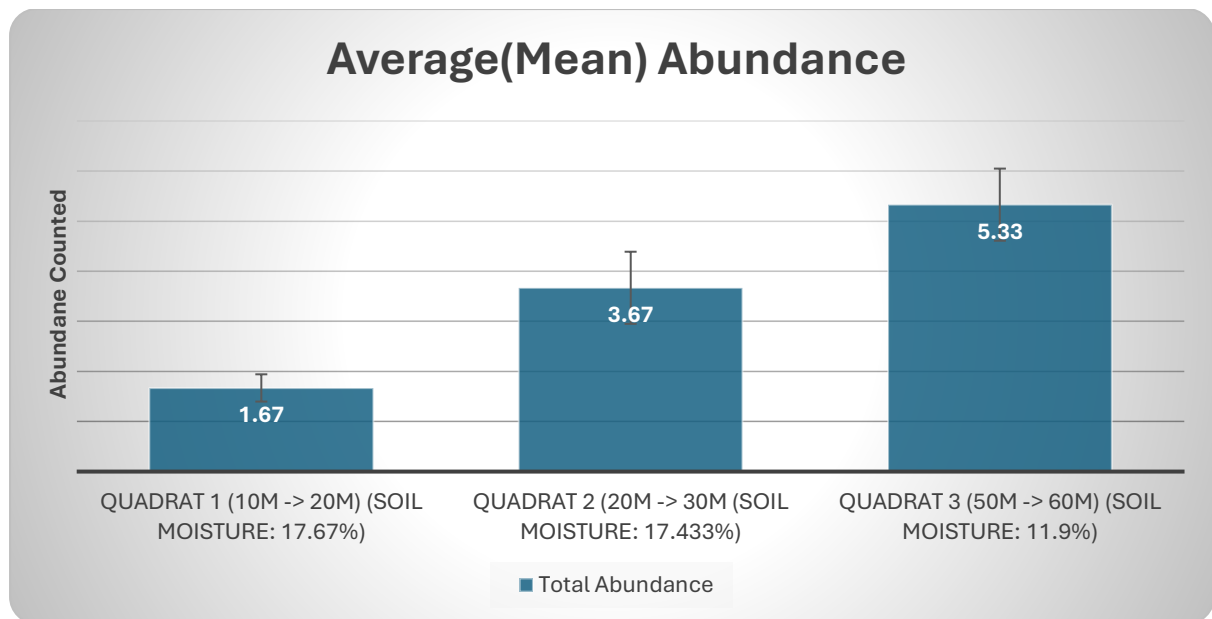
Interpretation:

Abundance of Eucalyptus species increased with distance from the creek, corresponding to a decrease in soil moisture. Species-specific distribution was observed: Blackbutt dominated the quadrat closest to the creek (Quadrat 1), Pink Bloodwood was most abundant in Quadrat 2, and Swamp Mahogany was most abundant in Quadrat 3. The slightly higher abundance in Quadrat 2 may be influenced by localised puddles, which temporarily increased soil moisture, affecting species growth.

Analysis:

The trend suggests that Eucalyptus species in this forest exhibit differential tolerance to soil moisture. Blackbutt appears more adapted to higher moisture levels near the creek, while Swamp Mahogany thrives in drier conditions further away. Quadrat 2's mixed results highlight microhabitat variability, showing that small-scale changes in soil moisture can influence species abundance. Overall, the data indicates that soil moisture is a key environmental factor shaping Eucalyptus distribution, and species-specific adaptations (such as leaf morphology and root depth) play a role in their competitive advantage along moisture gradients.

Figure 2: Mean Abundance with SEM Error Bars for 9 Quadrats



Interpretation:

Error bars represent the standard error of the mean (SEM) for each quadrat. Non-overlapping SEM bars suggest statistically significant differences in abundance between quadrats. The figure demonstrates that some quadrats consistently support higher Eucalyptus abundance than others, highlighting spatial variability within the study site.

Analysis:

The SEM values indicate precision of the mean estimates; smaller SEM suggests less variability among quadrats. Quadrats with higher abundance and smaller SEM (e.g., Quadrat 3) indicate consistent species growth in drier soils. These results support ecological theory that Eucalyptus species possess adaptations to low-moisture environments, including deep roots and water-conserving leaves (Feldman et al., 2021). The variation between quadrats also suggests that local factors such as microtopography, soil composition, and water availability influence species distribution. This figure reinforces the conclusion that soil moisture strongly affects Eucalyptus abundance and that species respond differently to moisture gradients.

7.0 Discussion:

Limitations:

- Outlier in Quadrat 2 due to puddles affected soil moisture readings.

- Rainfall fluctuations influenced soil moisture during measurements.
- Small sample size could affect statistical confidence despite low SD.
- Correlation ($p < 0.05$) does not confirm causation, other factors may influence abundance.

8.0 Sources of error:

Effecting reliability:

- Difficulty distinguishing Eucalyptus species; hybridisation can cause misidentification.

Effecting Validity:

- Sensor placement errors could misrepresent soil moisture experienced by plants.

9.0 Suggested improvements and Extensions:

Improvements:

- Better control of variables and enhanced Eucalyptus identification methods.
- Multiple checks per quadrat to reduce SEM and improve precision.

Extensions:

- Investigate additional abiotic factors such as light, temperature, and soil nutrients.
- Expand study to biodiversity assessment along transects to examine overall forest ecology.

10.0 Conclusion:

Data indicates that soil moisture influences Eucalyptus globulus abundance. Species were more abundant in drier areas, with Quadrat 3 showing the highest numbers. Findings support the hypothesis that Eucalyptus species are adapted to lower moisture environments in dry sclerophyll forests.

11.0 Bibliography:

Eucalyptus | Description, Major Species, & Uses. (n.d.). Encyclopedia Britannica.
<https://www.britannica.com/plant/Eucalyptus>

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[https://www.environment.nsw.gov.au/threatenedspeciesapp/VegFormation.aspx?formationName=Dry+sclerophyll+forests+\(shrubby+sub-formation\)#:~:text=Sclerophyll%20forests%20are%20a%20typically,than%20rainfall%2Fsoil%20moisture\).](https://www.environment.nsw.gov.au/threatenedspeciesapp/VegFormation.aspx?formationName=Dry+sclerophyll+forests+(shrubby+sub-formation)#:~:text=Sclerophyll%20forests%20are%20a%20typically,than%20rainfall%2Fsoil%20moisture).)

Soil Moisture. (2015, September 17). Soil Moisture | Earth Science Week.
<https://www.earthsciweek.org/classroom-activities/soil-moisture>

Feldman, A. F., Short Gianotti, D. J., Konings, A. G., Gentine, P., & Entekhabi, D. (2021, February 5). Patterns of plant rehydration and growth following pulses of soil moisture availability. BG - Patterns of Plant Rehydration and Growth Following Pulses of Soil Moisture Availability. <https://doi.org/10.5194/bg-18-831-2021>

12.0 Appendix:

Appendix 1:

	Transect Line - 1			Transect Line - 2			Transect Line - 3		
Abiotic Factors	Quadrat 1: 10 -> 20m	Quadrat 2: 20 -> 30m	Quadrat 3: 50 -> 60m	Quadrat 1: 10 -> 20m	Quadrat 2: 20 -> 30m	Quadrat 3: 50 -> 60m	Quadrat 1: 10 -> 20m	Quadrat 2: 20 -> 30m	Quadrat 3: 50 -> 60m
<u>Soil Moisture</u>	17.1	13.6	11.7	17.8	24.7	13.9	18.1	14	10.1
<u>Soil pH</u>	6	6	7	6	6.5	7.5	6.5	6.5	7
<u>Canopy Cover</u>	53%	57%	67%	54%	59%	62%	51%	54%	64%
<u>Temperature</u>	25	26	25	25	26	26	25	25	27

*Shaded Area = outlier, anomalous with respect to the rest of the data.