Relative influence of compaction, PH and vehicle disturbance on lifeforms within drylands of Yookamurra Sanctuary, River Murray catchment, South Australia.

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Abstract:

Vegetation patterns often affected by the soil pH, soil compaction and human mediated disturbance. Several studies have explored how pH, compaction and human disturbance have altered the ecosystem patterns, functioning and services. These studies about semi-arid drylands, explain how lifeforms and productivity resulting from soil acidity, hardness and human disturbance in arid-land. To further enhance the understanding of this correlation, we have surveyed five different eco-system within Yookamurra Sanctuary (Murray lands of South Australia), which is protecting over 5000 hectares of epidemic vegetation and wildlife species. Data has been collected by random sampling method with 150 quadrate samples for soil pH, soil compaction, litter depth, disturbance (Animal or Human) and lifeforms within Yookamurra region. Results suggest that the impacts of pH and compaction are varying across five different ecosystems. Moreover, vehicle disturbance has greater consequences at Roadside ecosystem. These findings amend our understanding of the interaction of soil characteristics with the vegetation patterns, especially in semi-arid region, such as Yookamurra wildlife sanctuary.

1. Introduction:

It is vital to understand how and what causes the influence on the lifeforms in Semi-arid lands to amend the management practices within drylands. Soil characteristics can have significant influence in dry conditions such as semi-arid region. According to de Caritat, Cooper and Wilford (2011), decrease in soil pH can lead to reduced biodiversity, functioning and ecosystem services. Furthermore, more compaction decreases the porosity of soil and, thus decreases the passage of water in the soil void space (Sidhu & Duiker 2006). Soil compaction level is vital for the root establishment and water flow. Soil compaction also accounts for the balance and growth of the plant hormones. Absorption of the vital nutrients is decreased or increased by the compactness of the soil (Kozlowski 1999).Along with these two factors, human mediated disturbance has negative impact on the vegetation. Based on these studies, predictions have been made to identify the relative influence of soil characteristics. According to the predictions, (1) if the pH increases, the number of lifeforms will be more. (2) if compaction will increase, lifeforms will be reduced. (3) the region with human mediated disturbance will have less lifeforms.

Thus, identifying the patterns between soil characteristics and lifeform will help to overcome the knowledge gap of how soil conditions are influencing the lifeforms within semi-arid region. This report will further discuss results and findings based on predefined predictions. These results would be helpful to understand the lifeforms patterns for the planning and implementation of the management practices for the semi-arid region at Yookamurra.

2. Methodology:

2.1 Study Site:

Yookamurra is located in Murray lands of South Australia, protecting over 5000 hectares of epidemic vegetation and wildlife species. It protects old Mallee, with trees that are hundreds of years old along with some of the threatened Australian species. It is a semi-arid zone of South Australia with an annual rainfall of 270 mm, between May to August. The region temperature also varies greatly during the year, as recorded maximum temperature during summer is 50^{o}C and minimum recorded temperature is -8^{o}C during winters. Soil are thin and based on the top layer of calcrete and rubbly limestone, which varies from sandy loam to limestone rubble with soils with 3.5 m depth (AWC 2018).

2.2 Data collection and analysis method:

We have surveyed five ecosystems with 500 m transect. Each had 30 randomly selected points. (Total number of samples 30 x 5=150). These Random numbers were based on the

distance along and away from the starting point. To locate the waypoints, we have used GPS. At each survey point, 1 x 1 m quadrant is used to take the sample data for soil properties. After locating particular point, we used range pole to measure 25 cm from midpoint in N, S, E and W. For each quadrant, soil pH, compactness, no. of individual life forms (Saltbush, cypress, Senna, shrub, herb, pea, wattle, Mallee, grass, figwort, twin leaves etc.) and human mediated disturbance have been noted. We have evaluated the results by using Linear regression analysis, ANOVA test for individual sites and Kruskal-Wallis test to identify the significance level of the soil conditions on the life forms. Results are presented with the graphical representation of pH Vs. Lifeforms and Compaction Vs. Lifeforms. to show the influence of the soil characteristics.

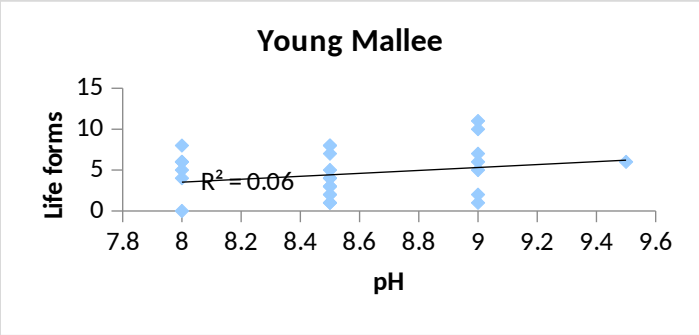
3. Results and Findings:

3.1 Responses of Soil pH on Lifeforms for different Ecosystem:

Value of R-squared for linear regression analysis representing the influence of the Soil pH on Lifeforms. If the value of R-square is close to 1, it is showing more influence of the soil pH on the lifeforms. Figure 1. Is representing the linear regression analysis for five different sites by defining the value of R^2. This analysis shows that there is little influence of the soil pH on the lifeforms. No significant difference has been observed due to the change in soil pH, because the mean soil pH for five different sites is relatively similar. It is vital to notice that the soil pH is influencing significantly at Saltbush and Roadside. At Saltbush, Lifeforms are increasing with the increase in soil pH. However, at Roadside, soil pH has negative influence on the lifeforms.

Here, by using ANOVA the value of Eta showing how soil pH and lifeforms are associated with each other. The higher the value of Eta, there is more influence of the soil pH on the lifeforms. For three sites, the value of Eta is between the range of 0.4-0.69, which represents modest influence of soil pH on the lifeforms. Furthermore, Old Mallee is representing low influence of the pH over lifeforms. As the value of Eta at Saltbush is between 0.7-0.89 and showing high association between the soil pH and Lifeforms.

(a)



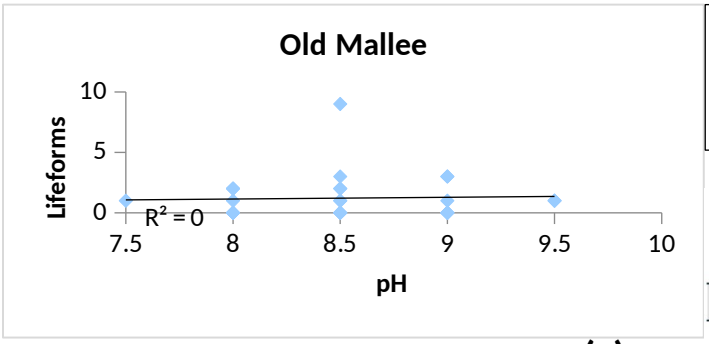
Mean pH-8.55
Std. Dev.-0.379

Lifeforms are increasing with the increase in pH

Measures of Association

	Eta	Eta Squared
pH * Lifeforms	.573	.328

(b)



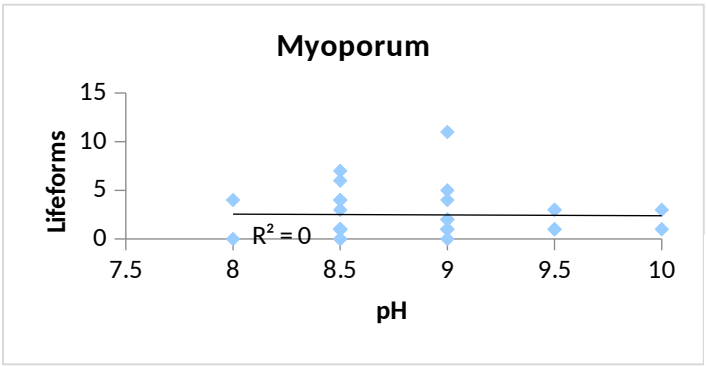
Mean pH-8.51
Std. dev.-0.516

Lifeforms are increasing with the increase in pH with low influence

Measures of Association

	Eta	Eta Squared
pH * Lifeforms	.311	.097

(c)



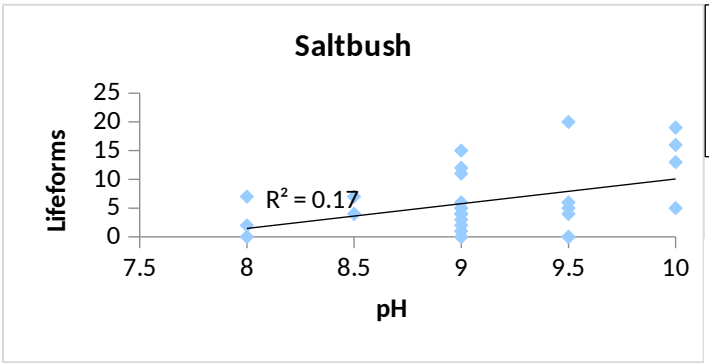
Mean pH-8.83
Std. dev.-0.530

Lifeforms have negligible influence of pH

Measures of Association

	Eta	Eta Squared
pH * Lifeforms	.563	.317

(d)



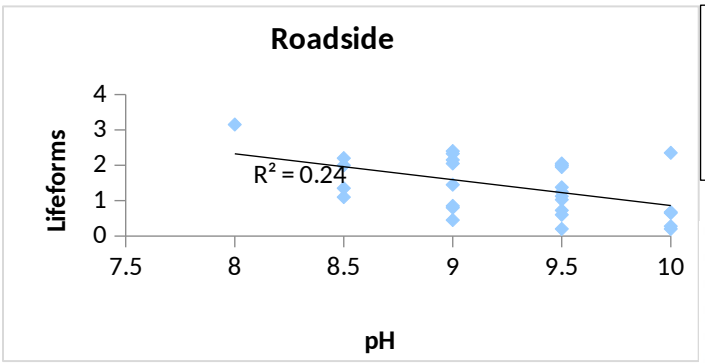
Mean pH-9.06
Std. dev.-0.568

Lifeforms are increasing with the increase in pH with very high

Measures of Association

	Eta	Eta Squared
pH * Lifeforms	.787	.620

(e)



Mean pH-9.25
Std. dev.-0.521

Lifeforms are decreasing with the increase in pH with very high influence

Measures of Association

	Eta	Eta Squared
pH * Lifeforms	.675	.456

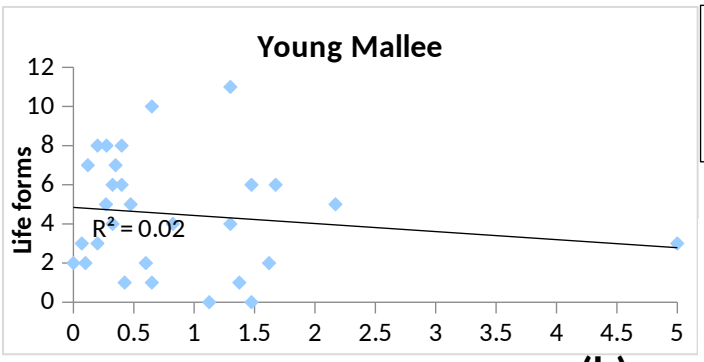
Fig. 1. Influence of soil pH on lifeforms for (a) Young Mallee (b) Old Mallee(c) Myoporum (d) Saltbush (e) Roadside.

3.2 Responses of Soil Compaction on Lifeforms for different Ecosystem:

The responses of the soil compaction on the lifeforms have analysed with the linear regression. Linear regression analysis represents (Fig.2.) the modest influence of the soil compactness on the lifeforms at the Yookamurra sanctuary. Lowest influence has been noticed at the myoporum between soil compactness and lifeforms (As the value of R^2 is 0.0093). Analysis suggests that the influence of compactness on lifeforms at all the sites is low to modest, as the values of the Eta is between 0.2-0.39 and 0.4-0.69. Roadside is showing the highest influence of the soil compactness and it is affecting the lifeforms as well. The number of lifeforms at the Roadside are on the lower side (variation in number of lifeforms is between 0-4, lowest compare to all other site). Results for Roadside representing that the level of compactness at roadside is not allowing plants to absorb required nutrients. As high compactness can also result into the soil porosity and reduced hydraulic conductivity, number of lifeforms at the roadside are relatively low compare to other four sites.

It is evident that the value of the Eta. for Saltbush and Roadside is similar, but the number of lifeforms at Saltbush is higher compare to Roadside. Therefore, high compactness cannot be the only reason for a smaller number of lifeforms at Roadside. As per our data, vehicle disturbance has been noticed at the roadside and it could be the cause for the lower number of lifeforms at Roadside.

(a)



Mean comp.-0.88
Std. dev.-0.977

Lifeforms are decreasing with the increase in the compaction

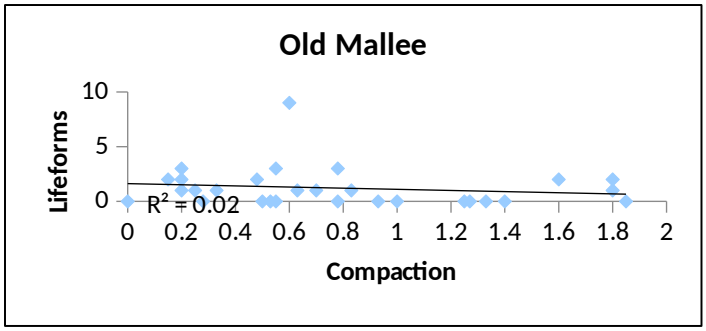
Measures of Association

	Eta	Eta Squared
Compaction * Lifeforms	.445	.198

(b)

Mean comp.-0.787
Std. dev.-0.541

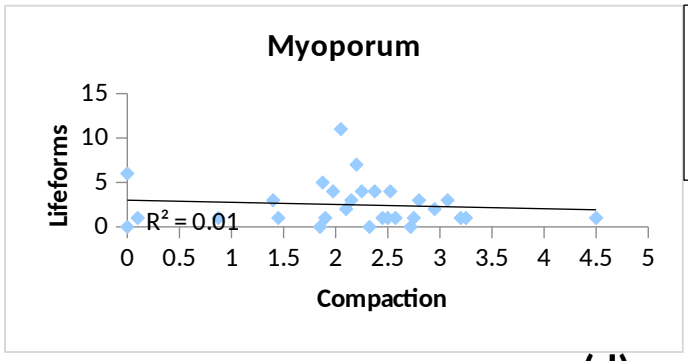
Lifeforms are decreasing with the increase in the compaction, but all 30 samples showing compaction < 2



Measures of Association

	Eta	Eta Squared
Compaction * Lifeforms	.259	.067

(c)



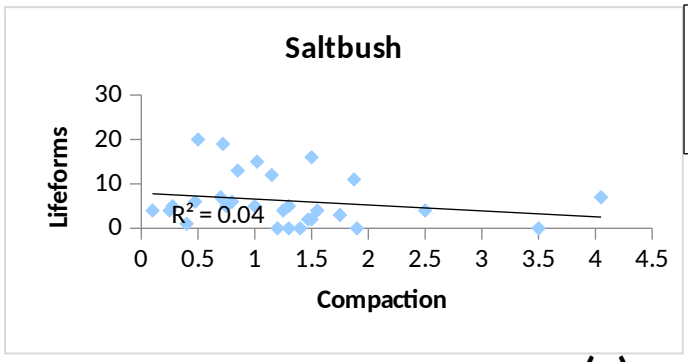
Mean comp.-2.11
Std. dev.- 0.989

Lifeforms are decreasing with the increase in the compaction with low influence

Measures of Association

	Eta	Eta Squared
Compaction * Lifeforms	.459	.210

(d)



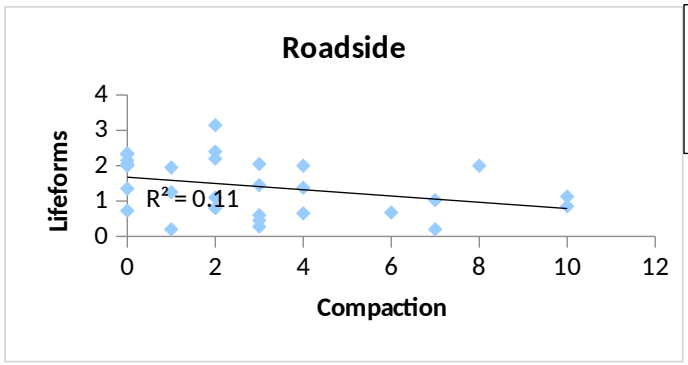
Mean comp.-1.26
Std. dev.-0.88

Lifeforms are decreasing with the increase in the compaction

Measures of Association

	Eta	Eta Squared
Compaction * Lifeforms	.623	.388

(e)



Mean comp-1.47
Std. dev.-0.86

Lifeforms are decreasing with the increase in the compaction

Measures of Association

	Eta	Eta Squared
Compaction * Lifeforms	.618	.382

Fig. 2. Influence of soil compaction on lifeforms for (a) Young Mallee (b) Old Mallee(c) Myoporum (d) Saltbush (e) Roadside.

3.3 Relative influence of pH, Compaction and Vehicle Disturbance at Yookamurra:

The influence of soil pH, compaction and animal disturbance is analysed with the Kruskal-Wallis test. To decide the available data are parametric or non-parametric, Descriptive analysis is performed. Table 1 is representing the values of Kurtosis and Skewness along with mean and standard deviation for soil pH, compaction and lifeforms. As shown in the table, descriptive statistics shows that the skewness and kurtosis for explanatory variables and lifeforms is not between -0.5 to +0.5. Therefore, the collected data is Non-parametric and suitable test is Kruskal-Wallis H test. Kruskal-Wallis H test is used to identify the significance level for 3 or more independent categories and scaled dependent variable.

Table 1. Descriptive Statistics

	Lifeforms	pH	Compaction
Mean	3.526666667	8.833333	1.29933333
Standard Error	0.323528735	0.047925	0.08001943
Median	2	9	1.175
Mode	0	9	0.2
Standard Deviation	3.962401595	0.586957	0.98003384
Sample Variance	15.7006264	0.344519	0.96046633
Kurtosis	4.143417373	-0.52351	1.08805502
Skewness	1.886377223	0.171925	0.99836119
Range	20	2.5	5
Minimum	0	7.5	0
Maximum	20	10	5
Sum	529	1325	194.9
Count	150	150	150

To perform the Kruskal- Wallis test, pH is categorised in 6 categories: category 1(7.1-7.5) Category 2(7.6-8.0) Category 3(8.1-8.5) Category 4(8.6-9.0) Category 5(9.10-9.5) Category 6(9.6-10.00). The results of the test showing that the value of significance is 0.323, which is >0.05 and thus it retains the null hypothesis and the distribution of the lifeforms is same for all categories of the Soil pH. Furthermore, Fig.3 is suggesting that the gaps between the mean values for each category are minimum, thus, all groups are identical.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Lifeform is the same across categories of PH.	Independent-Samples Kruskal-Wallis Test	.323	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

Figure 5 is suggesting the pH distribution across 6 six categories. According to Figure 5, large number of pH data are between the category 3(8.1-8.5) and category 4(8.6-9.0). Figure 6 is

suggesting that the influence of the soil pH on lifeforms is positive, but the value of R-squared representing that the influence is not significant.

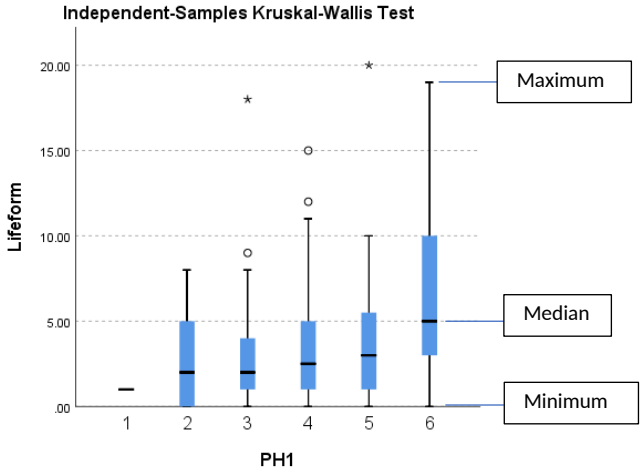


Fig. 3. Categorised distribution of lifeforms

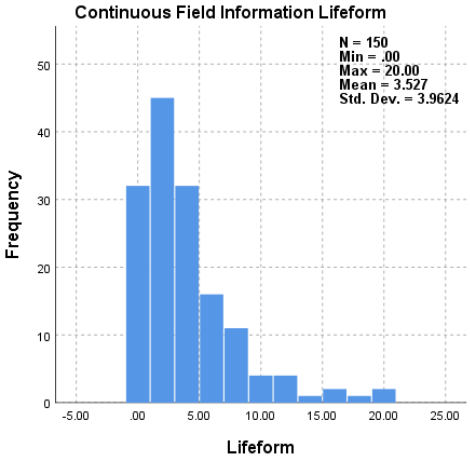


Fig.4. Frequency distribution of Lifeforms.

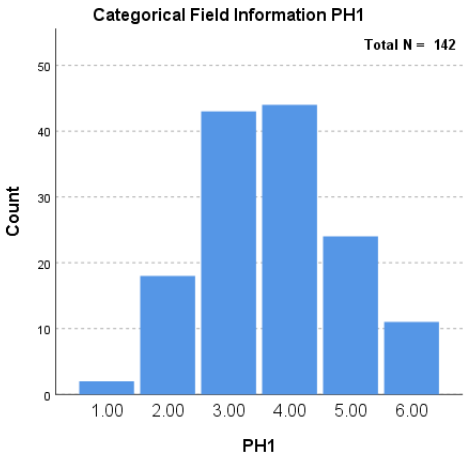


Fig. 5. Categorised distribution of pH

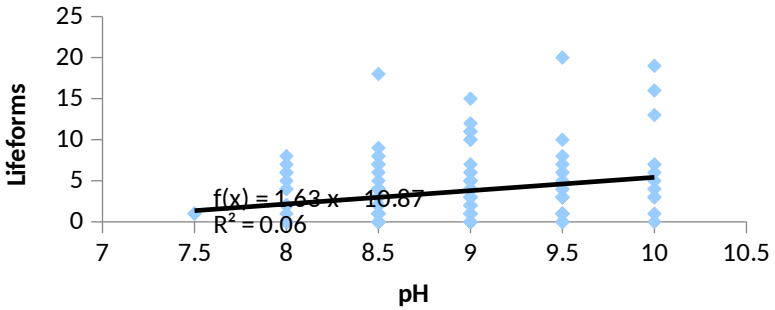


Fig.6. distribution of lifeforms across different pH level.

Compaction is categorised in 5 categories: category 1(0-1.0) Category 2(1.1-2.0) category 3(2.1-3.0) category 4(3.1-4.0) category 5(4.1-5.0). The results of the test showing that the value of significance is 0.048, which is <0.05 and thus it rejects the null hypothesis and suggest that there is no difference between the means and conclude that that a significant difference does exist.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Lifeform is the same across categories of Compaction1.	Independent-Samples Kruskal-Wallis Test	.048	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

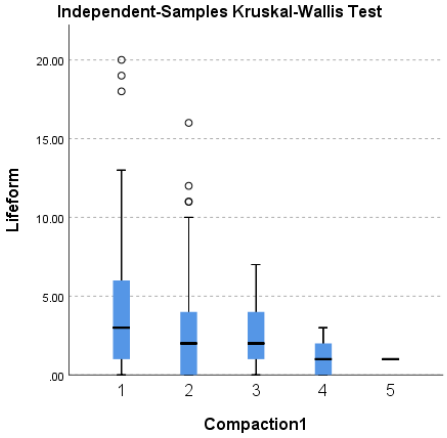


Fig. 7. Categorised distribution of lifeforms

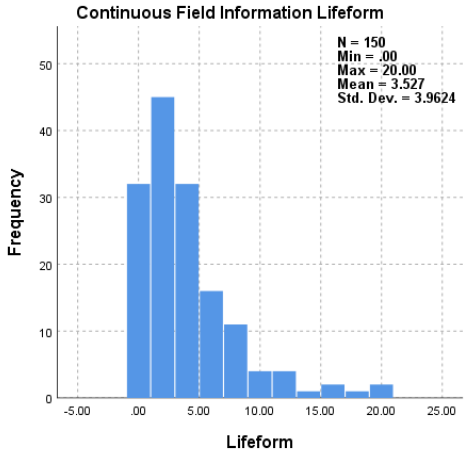


Fig.8. Frequency distribution of Lifeforms.

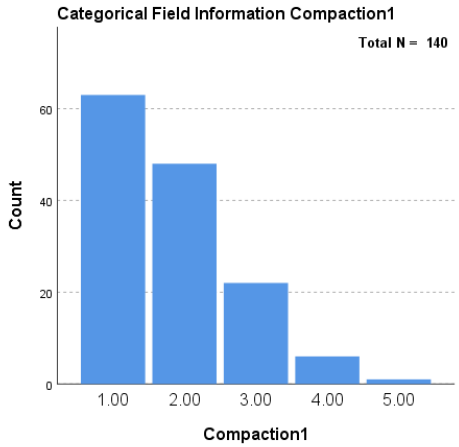


Fig. 9. Categorised distribution of Compaction

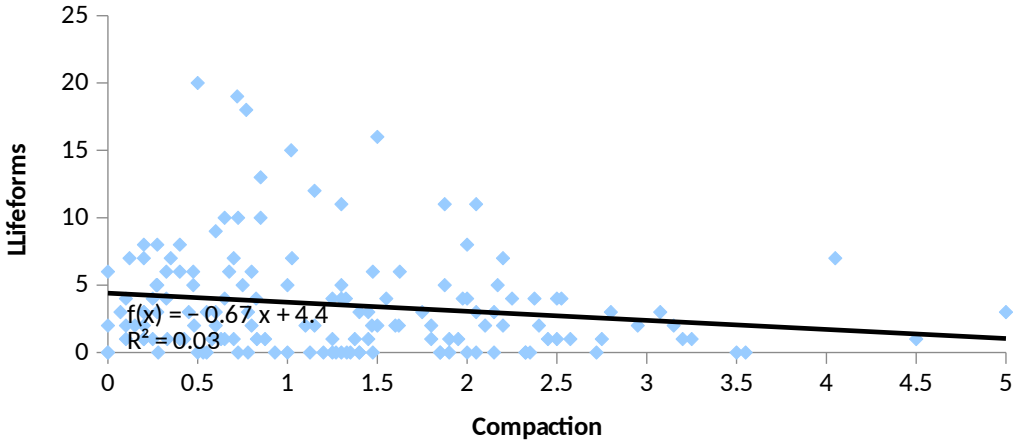


Fig.10. distribution of lifeforms across different compaction level.

It is evident that the lifeforms are decreasing with the increase in the soil compaction. From figure 9 and figure 10 it can be concluded that the large number of lifeforms are within category 1(0-1.0) and category 2(1.1-2.0). Mean value for the lifeform is 3.53 and standard deviation is 3.96 suggesting how lifeforms are varying across the data set.

Figure 11 is suggesting the impact of vehicle disturbance on the lifeforms. From the collected data, it can be summarised that the Roadside can have influence of the vehicle disturbance.

It is clear that the human mediated disturbance has a huge impact on the lifeforms. Figure 11 is indicating how much influence vehicle disturbance has on the number of lifeforms, as the roadside has the low vegetation density at Yookamurra. So, as per the predictions, human mediated disturbance could be threatening for the vegetation in Sem-arid lands.

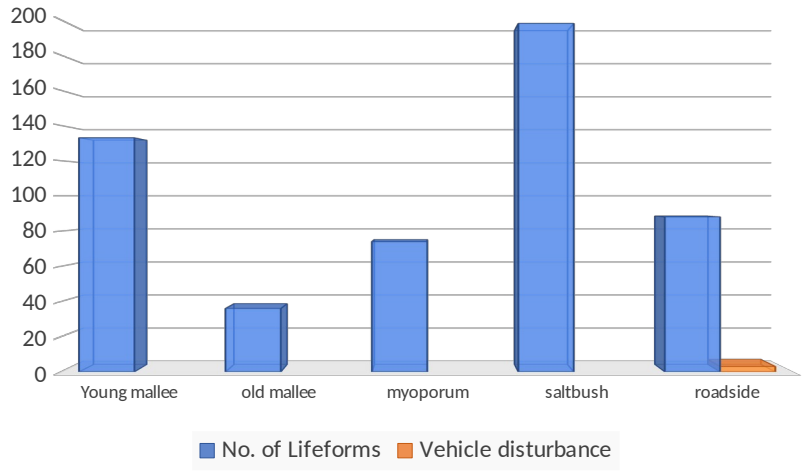


Fig.11. Vehicle Disturbance Vs. Lifeforms

4. Discussion and Conclusion:

Furthermore, there are few considerations of the research study. The data was collected within short time duration. Furthermore, influence on the vegetation by soil characteristics cannot be recognised by just analysing soil pH, compactness and disturbance because lifeforms can be affected by several other factors as well. These constraints should be avoided for more detailed data collection and analysis.

Table 2. Data analysis outcomes Vs. Predictions.

	Old Mallee (30)	Young Mallee (30)	Myoporam (30)	Saltbush (30)	Roadside (30)	Yookamurra Overall (150)
1. If pH increases, number of lifeforms will be more.	Y	Y	N (with very low influence)	Y	N	No Significant difference. P=0.323(>0.05)
2. If soil compaction increases, number of lifeforms will be reduced	Y	Y	Y	Y	Y	Significant difference. P=0.048(<0.05)
3. Negative impact of the human-mediated disturbance.	NA	NA	NA	NA	Y	No conclusive evidence to show the significance at Yookamurra

Y-As per Prediction. N-Not according to prediction. NA-Not Available

Table 2 is showing the results based on predictions and outcomes of the data analysis for five different sites. Soil characteristics are significant to plant growth, richness of plants, height and plant dominance. Results are suggesting low significance of the soil pH on the lifeforms at Yookamurra. As the mean of the pH is 8.8 and the variance is the lowest (0.88). Kruskal-Wallis-H test is suggesting Lifeforms distribution is equal across the categories of the pH. Secondly, compaction analysis is rejecting the null hypothesis and showing significance of the compaction over lifeforms. linear regression also representing number of lifeforms are decreasing with the increase in the compaction. Lastly, human mediated disturbance is causing more negative outcomes for the lifeforms at Yookamurra.

5. Recommendations:

This section includes steps to overcome the reduction of the lifeforms, especially in the semi-arid dryland such as Yookamurra Wildlife Sanctuary.

1. As invasion of weeds degrade the habitat for wildlife and vegetation, Practices used by indigenous people for the management of the invasive weeds should be implemented for betterment of the vegetation cover within the region. This also helps many species and ecosystems to rely on regular and occasional exposure to the fire.

2. Bilby, bandicoots and other mammals rejuvenate the soil by borrowing soil from one place to another, but feral are the biggest threat to these mammals. Therefore, feral invasion should be prevented through fencing or other means.

3. Natural regeneration should be used to remove and reduce the barriers for such as soil degradation, disturbance. This approach can also provide job opportunities to the community which helps to enhance the understanding of the significance of the semi-arid ecosystem.

4. Human disturbance should be controlled by sound-management, educating people about the significance of the arid-lands.

5. Effective decision making, and implementation would be the key to conservation. It comes with the knowledge, understanding the biodiversity attributes and nature. An innovative, enthusiastic programs of survey, research and seminars can bring enormous positive outcomes for Arid Lands.

6. References:

AWC 2018, *Yookamurra*, <https://www.australianwildlife.org/sanctuaries/yookamurra/>.

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