Comparing different scales on predictability of structral components in LAIs to LSAT metrics

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Background

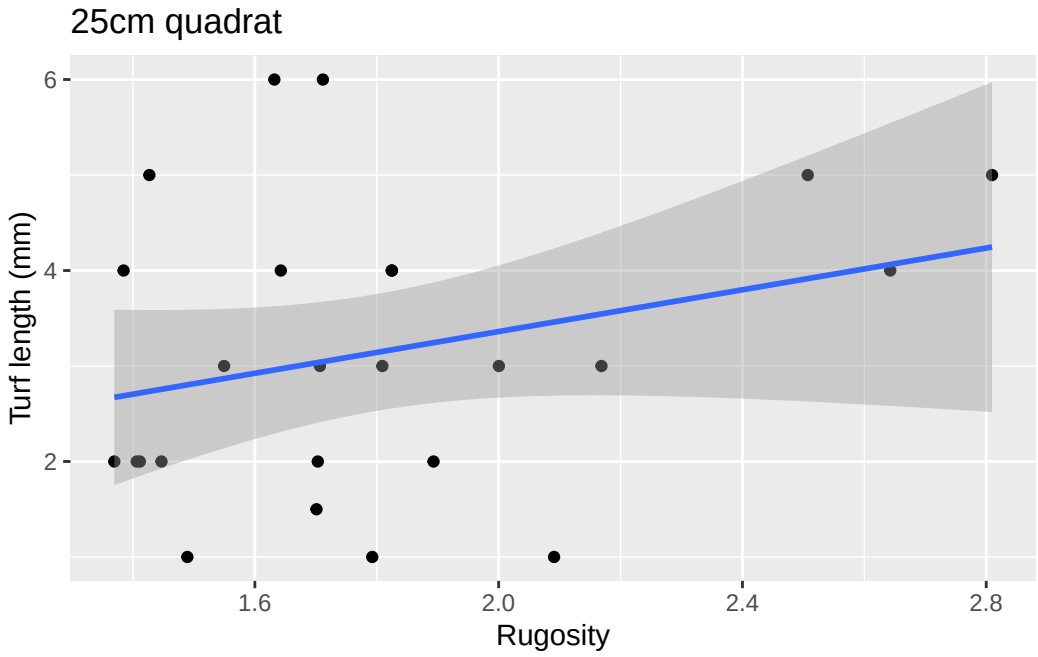
It's hypothesized that the limiting factor for LSAT growth and domination on the coral reef benthos is the structural complexity of the substrate, measured by rugosity and slope. Alain's 2024 paper did find an inverse relationship with reef habitat and LSAT abundance, showing that more structurally complex habitats had less LSAT coverage than those with less structure had more coverage. However, understanding specific metrics of the LSAT patches (turf height, sediment depth) were not explored as a function of structural complexity. We are exploring the possibility of quantifying this relationship using geostatistics extracted from large area images of the reef sites, using photogrammetry.

To do this, I went out in the field with Alain to capture one of the transects where LSAT sediment depth and turf length are measured, in 25 plots at each meter along a 25 meter transect, resulting in 25 plots. Each plot had a microquadrat of 25cm x 25cm where measurements were taken. The large area image of the transect was created in Metashape. In order to extract rugosity values, the point cloud was inserted into VISCORE, and a box in the dimensions of the microquadrat (25x25cm) was drawn to extract depth points along 20 transect lines in the box for further calculation of rugosity. This was repeated for a box of 50cm x 50cm and 100cm x 100cm. Next, the DEM was extracted from Metashape and imported to GIS, where the slope of each box (25x25cm, 50x50cm, 100x100cm) was calculated at each plot site.

After all information was extracted, processesing was ran in R using linear models to assess the relationship between these two structural values and the LSAT metrics.

Figure 1: Screen grab of GIS showing LAI with areas for structural elements extracted. Yellow dot is location of nail marking each point. Green box = 25cm, Blue box = 50cm, Pink box = 100cm. Note that in this image, there is 26 plots. The last plot in the series was removed.

Rugosity predicting Turf Length:

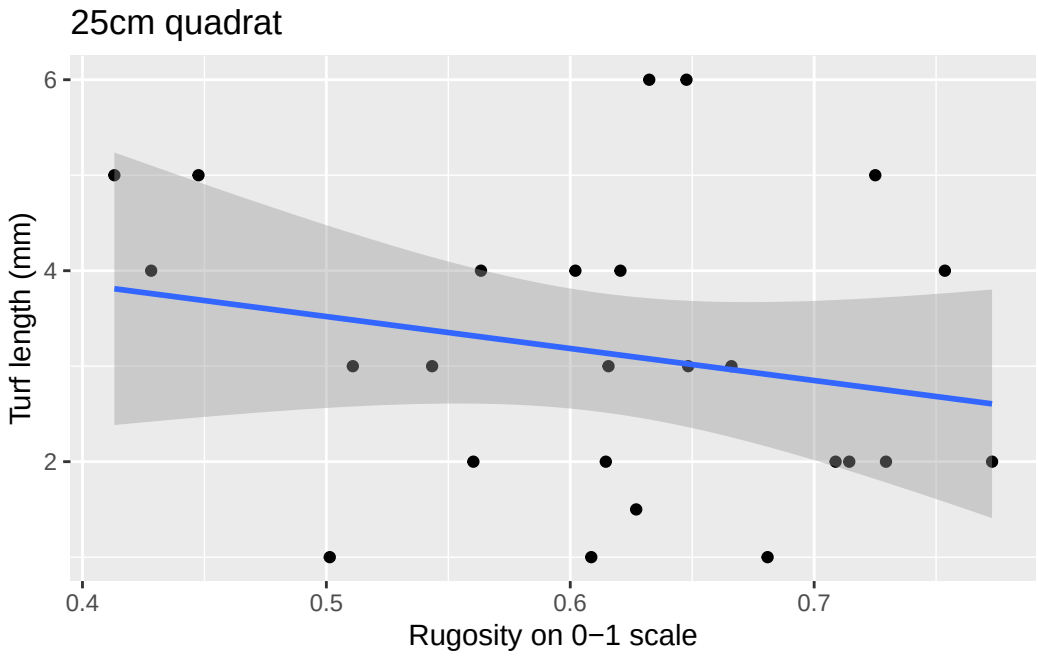


```
Call:
lm(formula = `Turf length (mm)` ~ avg_rugo25, data = rawdata25)

Residuals:
    Min      1Q  Median      3Q     Max
-2.4604 -0.7563 -0.1524  0.8306  3.0412

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   1.1751     1.4188   0.828    0.416
avg_rugo25    1.0929     0.7718   1.416    0.170

Residual standard error: 1.48 on 23 degrees of freedom
Multiple R-squared:  0.08019,   Adjusted R-squared:  0.0402
F-statistic: 2.005 on 1 and 23 DF,  p-value: 0.1702
```



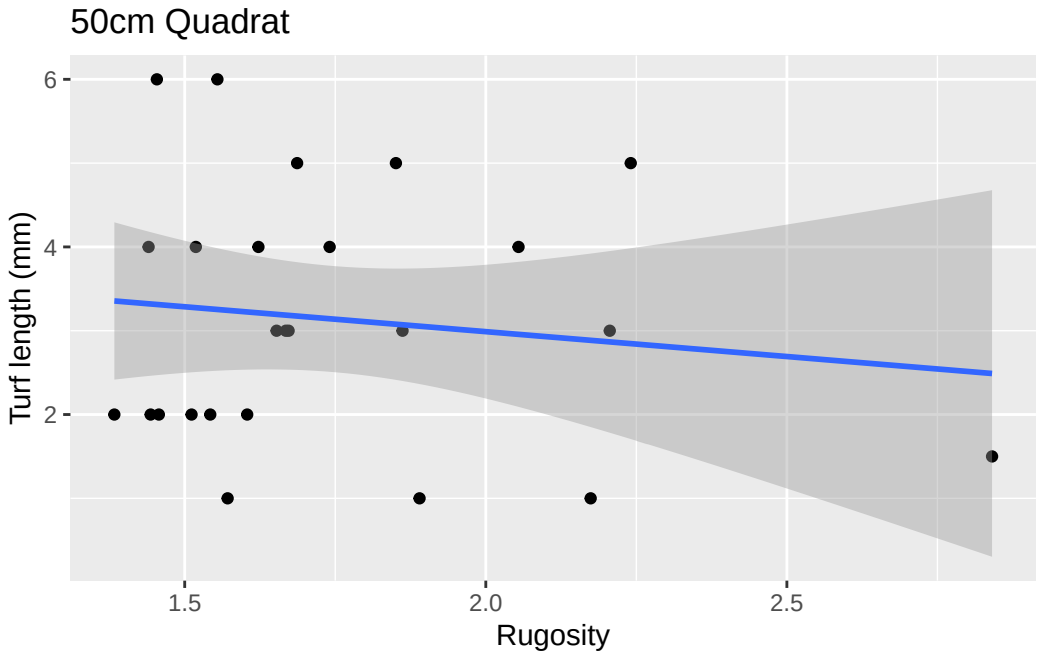

```
Call:
lm(formula = `Turf length (mm)` ~ rugo25_A, data = rawdata25)

Residuals:
    Min      1Q  Median      3Q     Max
```

```
-2.5153 -0.8207 -0.1325  0.8839  2.9745

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)    5.194      1.924   2.699   0.0128 *
rugo25_A      -3.349      3.098  -1.081   0.2909
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.505 on 23 degrees of freedom
Multiple R-squared:  0.04835,   Adjusted R-squared:  0.006971
F-statistic: 1.168 on 1 and 23 DF,  p-value: 0.2909
```



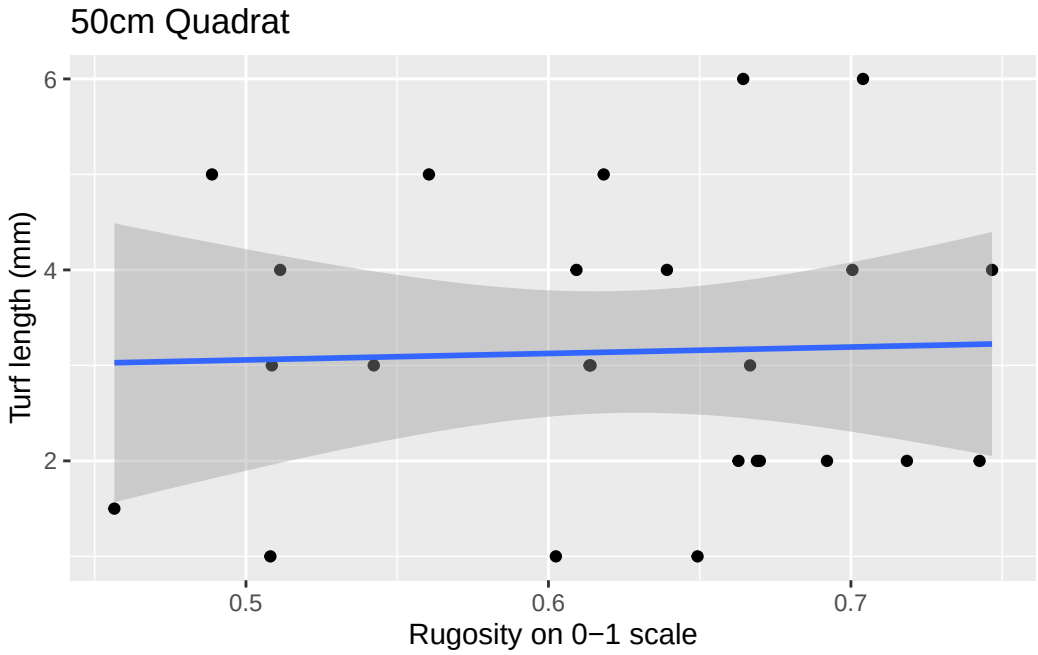

```
Call:
lm(formula = `Turf length (mm)` ~ avg_rugo50, data = rawdata50)

Residuals:
    Min      1Q  Median      3Q     Max
-2.2435 -1.2791 -0.1834  0.8571  2.7464

Coefficients:
```

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   4.1765     1.6419   2.544   0.0182 *
avg_rugo50   -0.5938     0.9241  -0.643   0.5269
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.529 on 23 degrees of freedom
Multiple R-squared:  0.01763,   Adjusted R-squared:  -0.02508
F-statistic: 0.4129 on 1 and 23 DF,  p-value: 0.5269
```

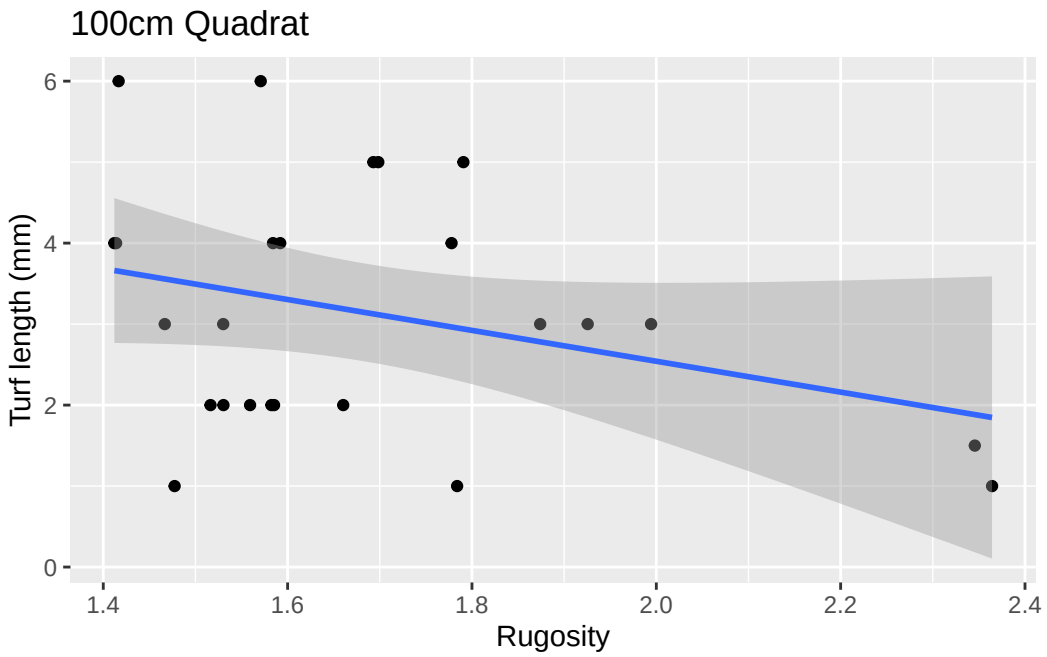



```
Call:
lm(formula = `Turf length (mm)` ~ rugo50_A, data = rawdata50)

Residuals:
    Min      1Q  Median      3Q     Max
-2.1582 -1.1871 -0.1341  0.8689  2.8316

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.7192     2.4023   1.132    0.269
rugo50_A      0.6761     3.8281   0.177    0.861
```

```
Residual standard error: 1.542 on 23 degrees of freedom
Multiple R-squared:  0.001354,  Adjusted R-squared:  -0.04206
F-statistic: 0.0312 on 1 and 23 DF,  p-value: 0.8614
```

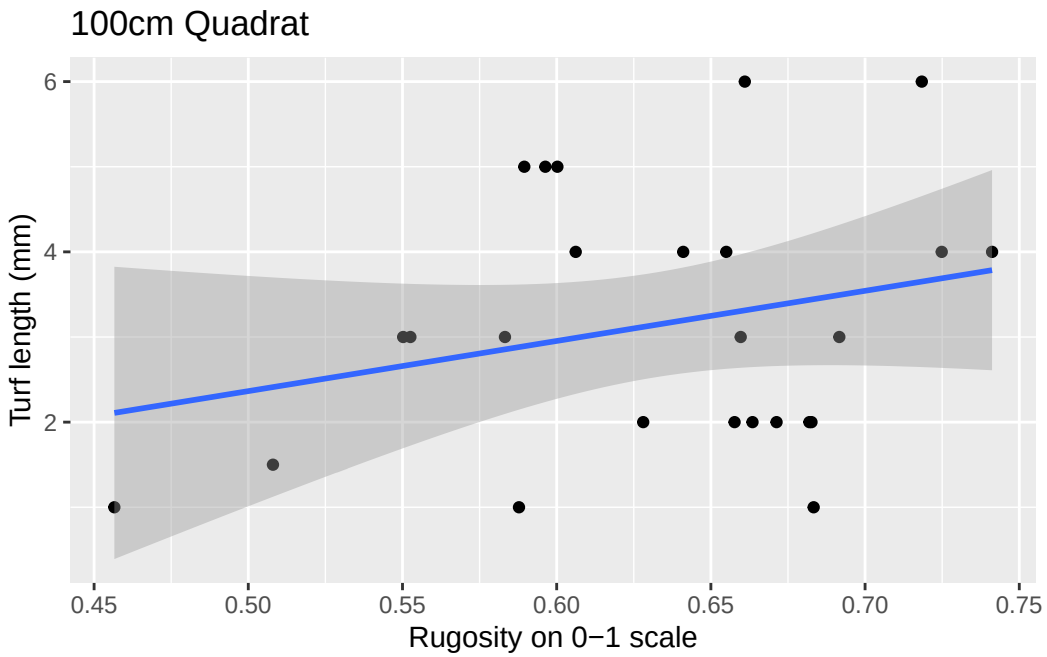



```
Call:
lm(formula = `Turf length (mm)` ~ avg_rugo100, data = rawdata100)

Residuals:
    Min      1Q  Median      3Q     Max
-2.5372 -1.3316  0.2186  0.6812  2.6409

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)    6.353      1.985   3.201  0.00397 **
avg_rugo100   -1.906      1.164  -1.637  0.11531
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.46 on 23 degrees of freedom
Multiple R-squared:  0.1043,    Adjusted R-squared:  0.06537
F-statistic: 2.679 on 1 and 23 DF,  p-value: 0.1153
```



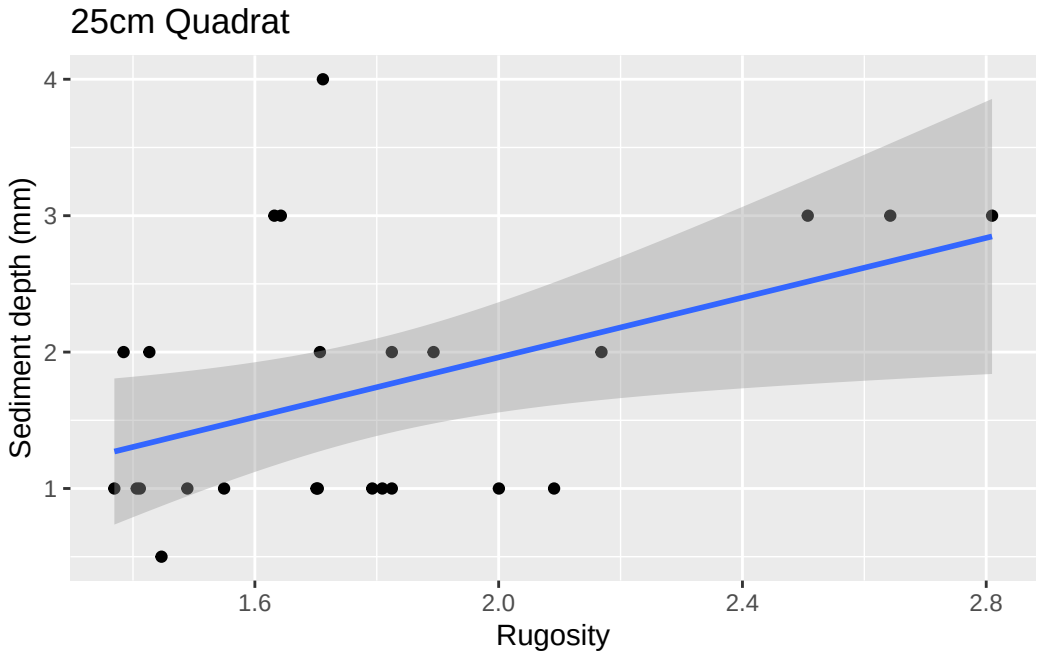

```
Call:
lm(formula = `Turf length (mm)` ~ rugo100_A, data = rawdata100)

Residuals:
    Min      1Q  Median      3Q     Max
-2.4443 -1.2932  0.1454  0.8049  2.6872

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.5812     2.8105  -0.207    0.838
rugo100_A     5.8910     4.4244   1.331    0.196

Residual standard error: 1.487 on 23 degrees of freedom
Multiple R-squared:  0.07156,   Adjusted R-squared:  0.0312
F-statistic: 1.773 on 1 and 23 DF,  p-value: 0.1961
```

Rugosity predicting Sediment Depth:

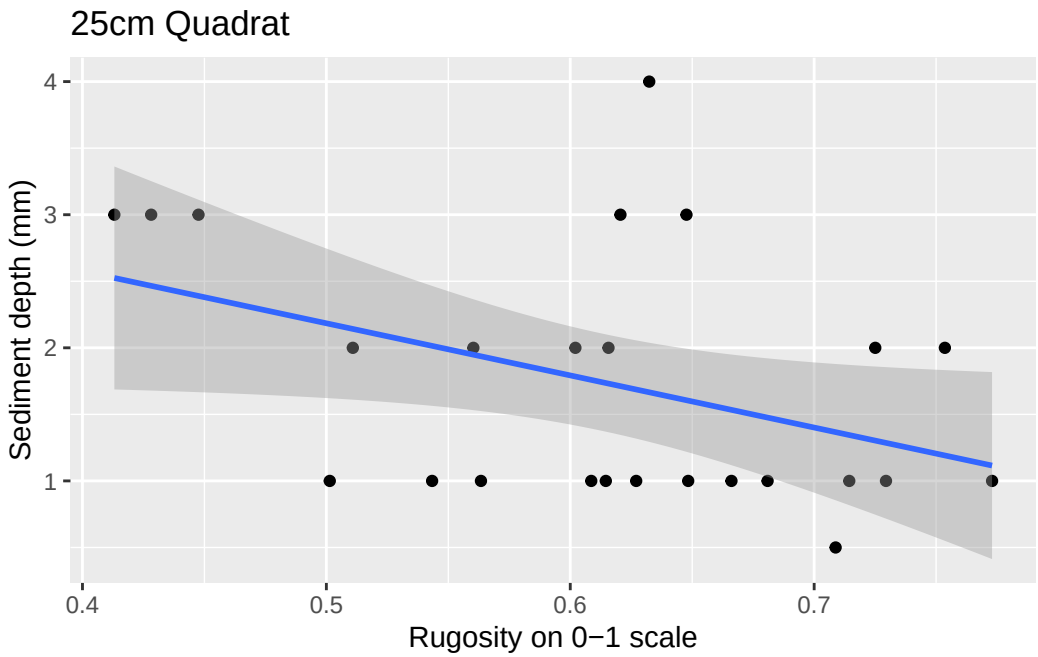



```
Call:
lm(formula = `Sediment depth (mm)` ~ avg_rugo25, data = rawdata25)

Residuals:
    Min      1Q  Median      3Q     Max
-1.0610 -0.6364 -0.2710  0.3597  2.3543

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.2284     0.8280  -0.276   0.7851
avg_rugo25    1.0949     0.4504   2.431   0.0233 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8636 on 23 degrees of freedom
Multiple R-squared:  0.2044,    Adjusted R-squared:  0.1698
F-statistic: 5.909 on 1 and 23 DF,  p-value: 0.02327
```

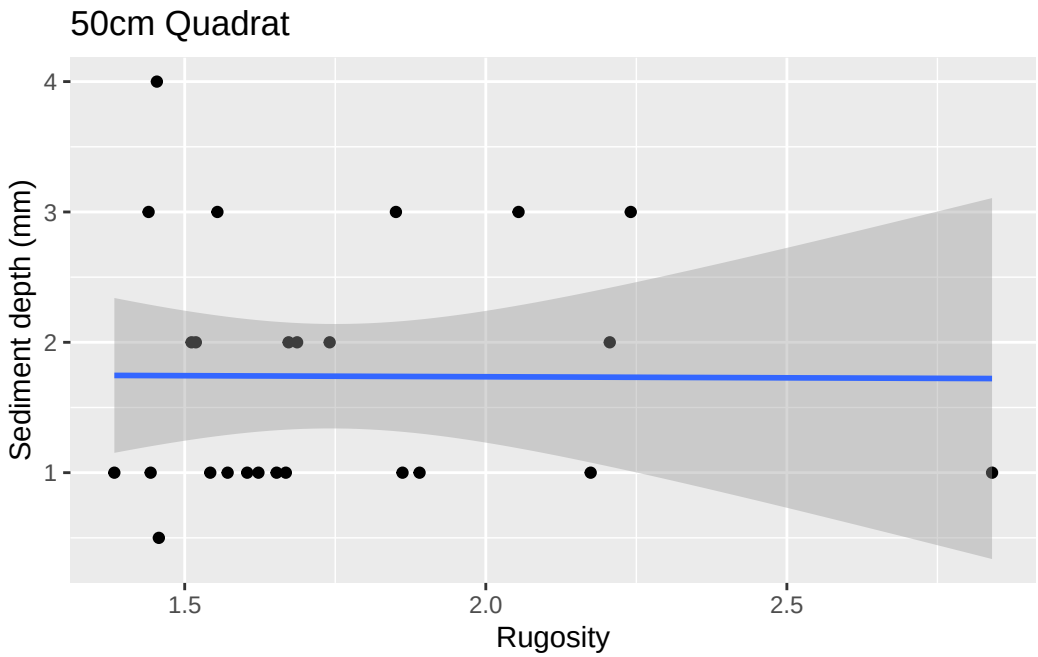



```
Call:
lm(formula = `Sediment depth (mm)` ~ rugo25_A, data = rawdata25)

Residuals:
    Min      1Q  Median      3Q     Max
-1.1789 -0.6868 -0.1418  0.5344  2.3341

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)    4.142      1.129   3.669  0.00127 **
rugo25_A      -3.916      1.818  -2.154  0.04191 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8832 on 23 degrees of freedom
Multiple R-squared:  0.1679,    Adjusted R-squared:  0.1317
F-statistic: 4.642 on 1 and 23 DF,  p-value: 0.04191
```

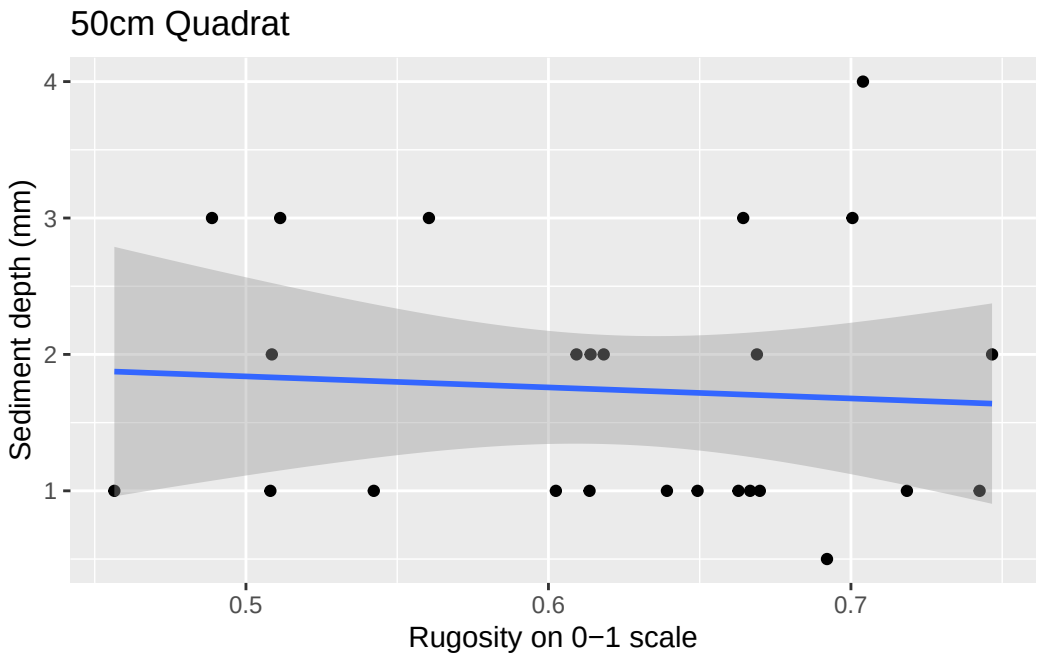



```
Call:
lm(formula = `Sediment depth (mm)` ~ avg_rugo50, data = rawdata50)

Residuals:
    Min      1Q  Median      3Q     Max
-1.2447 -0.7420 -0.7220  0.2676  2.2552

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.76865    1.03945   1.702    0.102
avg_rugo50  -0.01641    0.58504  -0.028    0.978

Residual standard error: 0.9682 on 23 degrees of freedom
Multiple R-squared:  3.423e-05, Adjusted R-squared:  -0.04344
F-statistic: 0.0007872 on 1 and 23 DF,  p-value: 0.9779
```

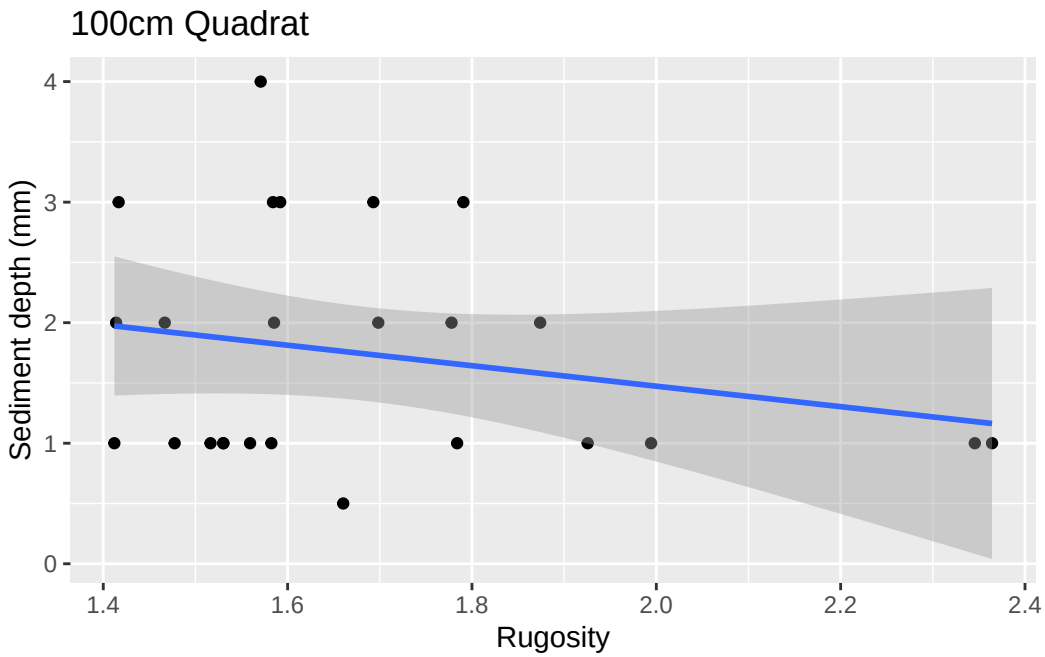



```
Call:
lm(formula = `Sediment depth (mm)` ~ rugo50_A, data = rawdata50)

Residuals:
    Min      1Q  Median      3Q     Max
-1.1836 -0.7264 -0.6429  0.3605  2.3260

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.2430     1.5047   1.491    0.150
rugo50_A     -0.8083     2.3977  -0.337    0.739

Residual standard error: 0.9658 on 23 degrees of freedom
Multiple R-squared:  0.004916,  Adjusted R-squared:  -0.03835
F-statistic: 0.1136 on 1 and 23 DF,  p-value: 0.7391
```

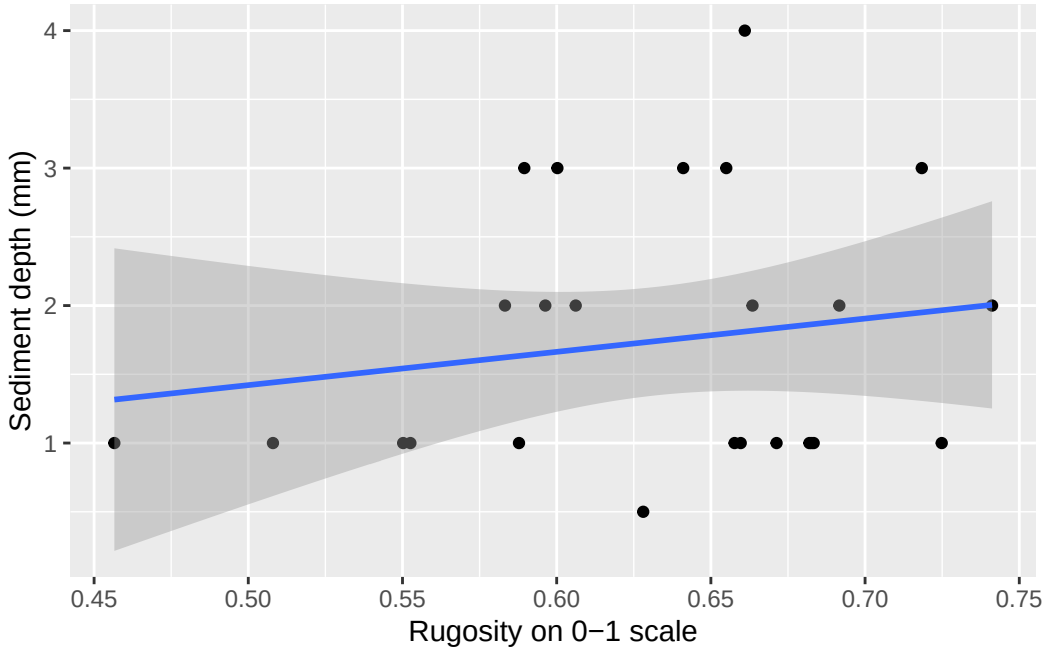



```
Call:
lm(formula = `Sediment depth (mm)` ~ avg_rugo100, data = rawdata100)

Residuals:
    Min      1Q  Median      3Q     Max
-1.2617 -0.8475 -0.1636  0.4199  2.1623

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   3.1723     1.2808   2.477    0.021 *
avg_rugo100  -0.8496     0.7515  -1.131    0.270
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9424 on 23 degrees of freedom
Multiple R-squared:  0.05265,   Adjusted R-squared:  0.01146
F-statistic: 1.278 on 1 and 23 DF,  p-value: 0.2699
```



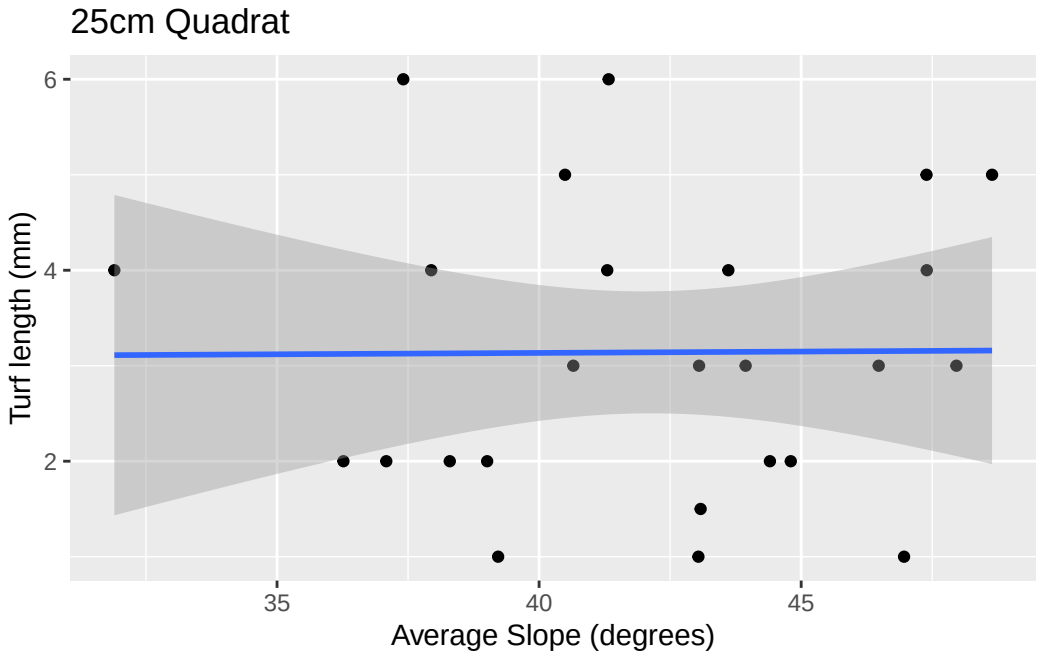

```
Call:
lm(formula = `Sediment depth (mm)` ~ rugo100_A, data = rawdata100)

Residuals:
    Min      1Q  Median      3Q     Max
-1.2313 -0.8078 -0.3161  0.3773  2.1890

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.2106     1.8019   0.117    0.908
rugo100_A     2.4211     2.8366   0.854    0.402

Residual standard error: 0.9532 on 23 degrees of freedom
Multiple R-squared:  0.0307,    Adjusted R-squared:  -0.01144
F-statistic: 0.7285 on 1 and 23 DF,  p-value: 0.4022
```

Slope predicting Turf Length:

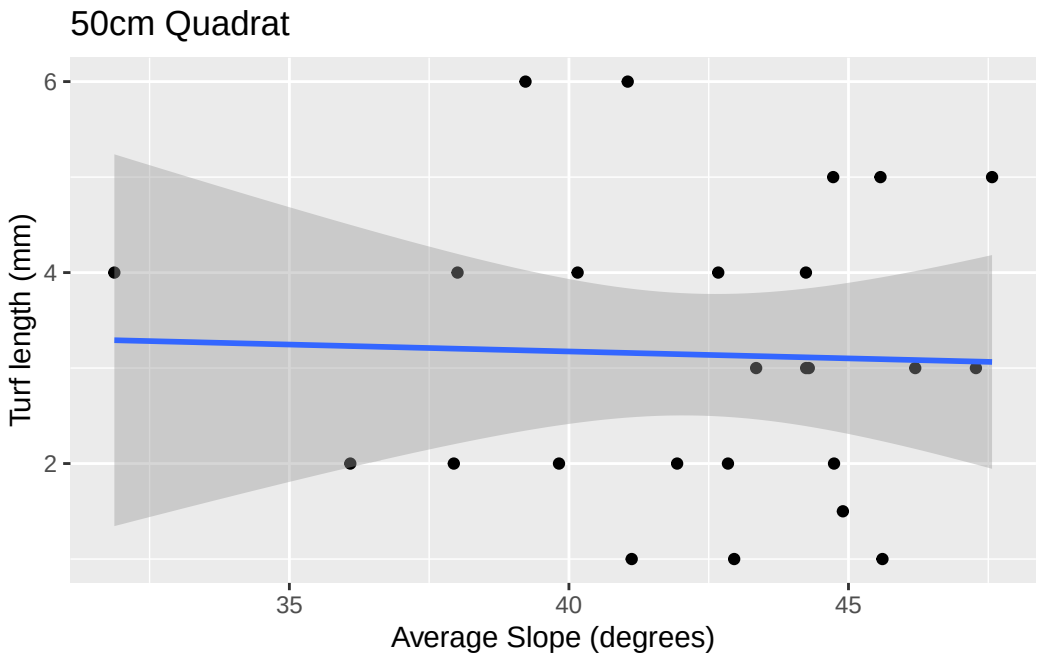



```
Call:
lm(formula = `Turf length (mm)` ~ MEAN, data = rawdata25)

Residuals:
    Min      1Q  Median      3Q     Max
-2.1540 -1.1313 -0.1454  0.8718  2.8733

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 3.019875   3.117123   0.969    0.343
MEAN        0.002856   0.073736   0.039    0.969

Residual standard error: 1.543 on 23 degrees of freedom
Multiple R-squared:  6.52e-05,  Adjusted R-squared:  -0.04341
F-statistic: 0.0015 on 1 and 23 DF,  p-value: 0.9694
```

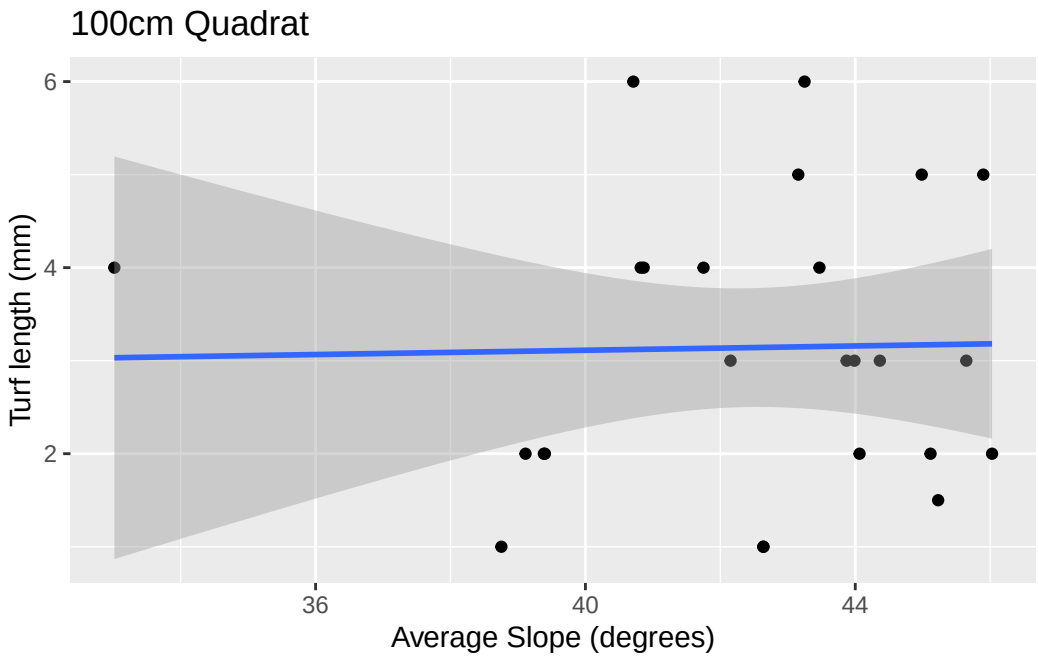



```
Call:
lm(formula = `Turf length (mm)` ~ MEAN, data = rawdata50)

Residuals:
    Min      1Q  Median      3Q     Max
-2.1576 -1.1764 -0.1117  0.8649  2.8414

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.75324    3.60997    1.04    0.309
MEAN        -0.01449    0.08496   -0.17    0.866

Residual standard error: 1.542 on 23 degrees of freedom
Multiple R-squared:  0.001262,  Adjusted R-squared:  -0.04216
F-statistic: 0.02907 on 1 and 23 DF,  p-value: 0.8661
```



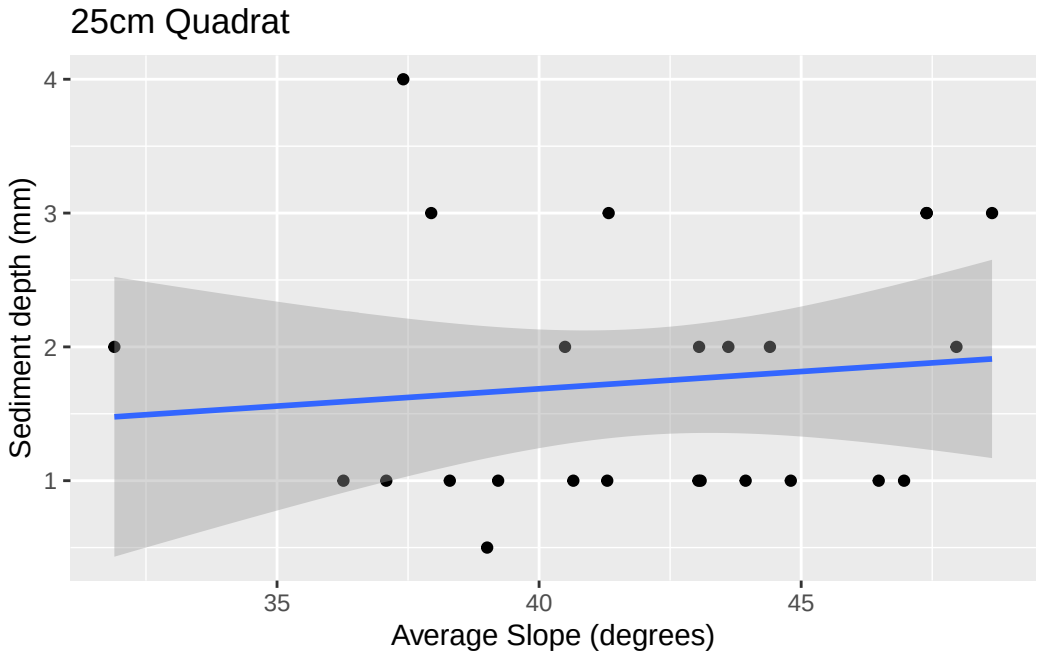

```
Call:
lm(formula = `Turf length (mm)` ~ MEAN, data = rawdata100)

Residuals:
    Min      1Q  Median      3Q     Max
-2.1426 -1.1590 -0.1582  0.8784  2.8796

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.65063    4.52221   0.586    0.563
MEAN         0.01154    0.10638   0.108    0.915

Residual standard error: 1.543 on 23 degrees of freedom
Multiple R-squared:  0.0005113, Adjusted R-squared:  -0.04294
F-statistic: 0.01177 on 1 and 23 DF,  p-value: 0.9146
```

Slope predicting Sediment Depth:

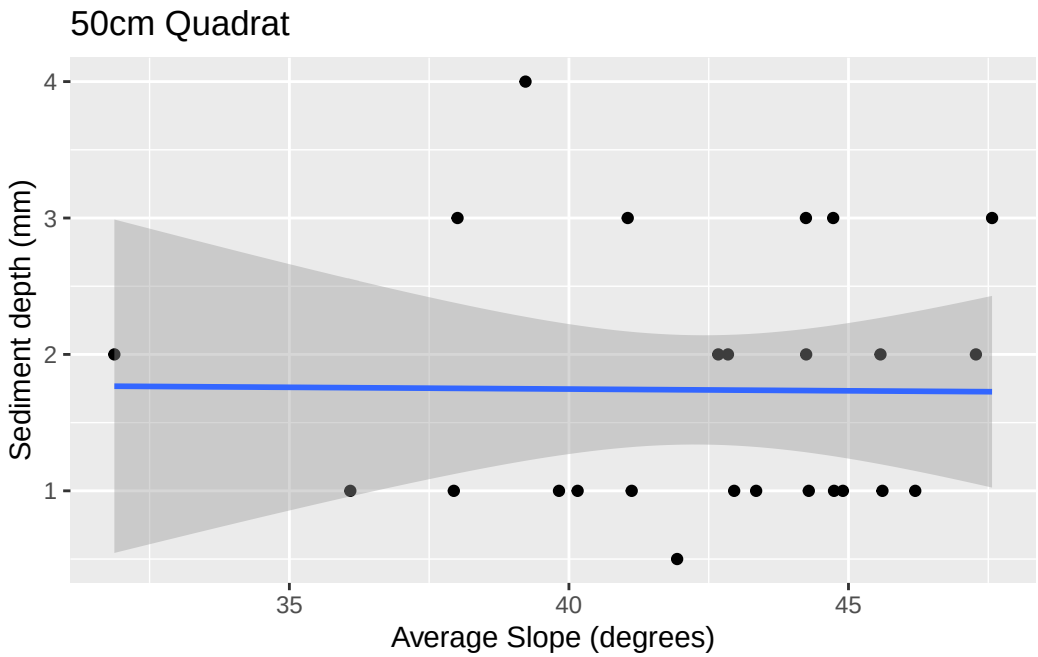



```
Call:
lm(formula = `Sediment depth (mm)` ~ MEAN, data = rawdata25)

Residuals:
    Min      1Q  Median      3Q     Max
-1.1610 -0.7651 -0.5902  0.5227  2.3803

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.65340    1.94267   0.336    0.740
MEAN         0.02583    0.04595   0.562    0.579

Residual standard error: 0.9616 on 23 degrees of freedom
Multiple R-squared:  0.01355,   Adjusted R-squared:  -0.02934
F-statistic: 0.316 on 1 and 23 DF,  p-value: 0.5795
```

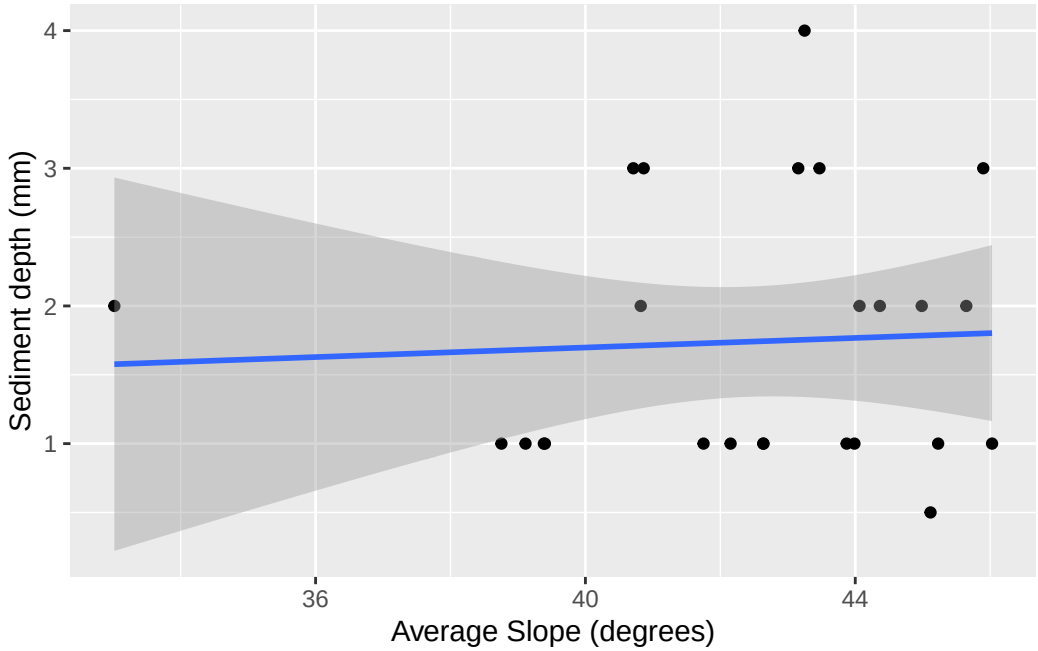



```
Call:
lm(formula = `Sediment depth (mm)` ~ MEAN, data = rawdata50)

Residuals:
    Min      1Q  Median      3Q     Max
-1.2410 -0.7384 -0.7301  0.2727  2.2520

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.849053   2.266465   0.816    0.423
MEAN        -0.002576   0.053339  -0.048    0.962

Residual standard error: 0.9681 on 23 degrees of freedom
Multiple R-squared:  0.0001014, Adjusted R-squared:  -0.04337
F-statistic: 0.002332 on 1 and 23 DF,  p-value: 0.9619
```




```
Call:
lm(formula = `Sediment depth (mm)` ~ MEAN, data = rawdata100)

Residuals:
    Min      1Q  Median      3Q     Max
-1.2870 -0.7439 -0.6764  0.4232  2.2455

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.00307    2.83409   0.354    0.727
MEAN         0.01738    0.06667   0.261    0.797

Residual standard error: 0.9668 on 23 degrees of freedom
Multiple R-squared:  0.002945,  Adjusted R-squared:  -0.04041
F-statistic: 0.06793 on 1 and 23 DF,  p-value: 0.7967
```