**NL ~ Site*Year*Treatment + Species + (1|PlotPair) + (1|Plot\_ID) + (1|Subplot\_ID), data = year)**

## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients

## boundary (singular) fit: see ?isSingular

## Missing cells for: SiteALP:TreatmentEarly, SiteALP:Year2017:TreatmentEarly, SiteALP:Year2018:TreatmentEarly.   
## Interpret type III hypotheses with care.

## Type III Analysis of Variance Table with Kenward-Roger's method  
## Sum Sq Mean Sq NumDF DenDF F value Pr(>F)   
## Site 1992.8 498.20 4 20.84 28.9353 3.056e-08 \*\*\*  
## Year 77.3 77.28 1 1444.97 4.5524 0.03304 \*   
## Treatment 69.0 68.95 1 8.44 4.0620 0.07678 .   
## Species 6844.1 86.63 79 1425.93 5.1031 < 2.2e-16 \*\*\*  
## Site:Year 1615.1 403.79 4 1433.67 23.7857 < 2.2e-16 \*\*\*  
## Site:Treatment 38.0 12.66 3 8.31 0.7452 0.55370   
## Year:Treatment 61.2 61.23 1 1434.26 3.6067 0.05775 .   
## Site:Year:Treatment 44.5 14.83 3 1424.18 0.8738 0.45400   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## $emmeans  
## Site = ALP, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 7.23 1.342 680.0 4.60 9.87  
## 2018 5.94 0.766 111.8 4.42 7.45  
##   
## Site = LM, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 13.47 0.653 71.6 12.17 14.77  
## 2018 8.65 0.647 69.0 7.36 9.94  
##   
## Site = LSA, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 5.29 0.602 51.8 4.08 6.50  
## 2018 5.49 0.575 43.4 4.33 6.65  
##   
## Site = UM, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 5.61 0.585 46.8 4.44 6.79  
## 2018 6.94 0.572 42.8 5.79 8.09  
##   
## Site = USA, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 6.46 0.736 110.6 5.00 7.91  
## 2018 5.81 0.643 67.4 4.53 7.10  
##   
## Site = ALP, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 nonEst NA NA NA NA  
## 2018 nonEst NA NA NA NA  
##   
## Site = LM, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 12.46 0.685 85.6 11.10 13.83  
## 2018 9.34 0.601 47.1 8.13 10.55  
##   
## Site = LSA, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 5.82 0.611 55.2 4.59 7.04  
## 2018 6.57 0.574 43.0 5.41 7.73  
##   
## Site = UM, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 6.05 0.584 46.4 4.87 7.23  
## 2018 8.78 0.568 41.5 7.63 9.92  
##   
## Site = USA, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 7.38 0.683 80.5 6.02 8.74  
## 2018 6.49 0.610 55.0 5.27 7.71  
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger   
## Confidence level used: 0.95   
##   
## $contrasts  
## Site = ALP, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 1.297 1.410 1395 0.920 0.3578   
##   
## Site = LM, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 4.821 0.689 1415 6.993 <.0001   
##   
## Site = LSA, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -0.197 0.594 1153 -0.332 0.7398   
##   
## Site = UM, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -1.325 0.572 1411 -2.317 0.0206   
##   
## Site = USA, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 0.644 0.743 1441 0.866 0.3867   
##   
## Site = ALP, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 nonEst NA NA NA NA   
##   
## Site = LM, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 3.123 0.664 1042 4.701 <.0001   
##   
## Site = LSA, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -0.753 0.602 1405 -1.251 0.2110   
##   
## Site = UM, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -2.729 0.563 1413 -4.844 <.0001   
##   
## Site = USA, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 0.895 0.669 1421 1.339 0.1809   
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger

## $emmeans  
## Year = 2017, Site = ALP:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 7.23 1.342 680.0 4.60 9.87  
## Early nonEst NA NA NA NA  
##   
## Year = 2018, Site = ALP:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 5.94 0.766 111.8 4.42 7.45  
## Early nonEst NA NA NA NA  
##   
## Year = 2017, Site = LM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 13.47 0.653 71.6 12.17 14.77  
## Early 12.46 0.685 85.6 11.10 13.83  
##   
## Year = 2018, Site = LM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 8.65 0.647 69.0 7.36 9.94  
## Early 9.34 0.601 47.1 8.13 10.55  
##   
## Year = 2017, Site = LSA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 5.29 0.602 51.8 4.08 6.50  
## Early 5.82 0.611 55.2 4.59 7.04  
##   
## Year = 2018, Site = LSA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 5.49 0.575 43.4 4.33 6.65  
## Early 6.57 0.574 43.0 5.41 7.73  
##   
## Year = 2017, Site = UM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 5.61 0.585 46.8 4.44 6.79  
## Early 6.05 0.584 46.4 4.87 7.23  
##   
## Year = 2018, Site = UM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 6.94 0.572 42.8 5.79 8.09  
## Early 8.78 0.568 41.5 7.63 9.92  
##   
## Year = 2017, Site = USA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 6.46 0.736 110.6 5.00 7.91  
## Early 7.38 0.683 80.5 6.02 8.74  
##   
## Year = 2018, Site = USA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 5.81 0.643 67.4 4.53 7.10  
## Early 6.49 0.610 55.0 5.27 7.71  
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger   
## Confidence level used: 0.95   
##   
## $contrasts  
## Year = 2017, Site = ALP:  
## contrast estimate SE df t.ratio p.value  
## Control - Early nonEst NA NA NA NA   
##   
## Year = 2018, Site = ALP:  
## contrast estimate SE df t.ratio p.value  
## Control - Early nonEst NA NA NA NA   
##   
## Year = 2017, Site = LM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 1.004 0.849 25.6 1.183 0.2475   
##   
## Year = 2018, Site = LM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.694 0.782 18.1 -0.888 0.3862   
##   
## Year = 2017, Site = LSA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.526 0.768 17.3 -0.685 0.5027   
##   
## Year = 2018, Site = LSA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -1.081 0.728 13.9 -1.487 0.1595   
##   
## Year = 2017, Site = UM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.437 0.729 14.2 -0.599 0.5589   
##   
## Year = 2018, Site = UM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -1.840 0.718 13.3 -2.564 0.0233   
##   
## Year = 2017, Site = USA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.927 0.908 32.4 -1.021 0.3147   
##   
## Year = 2018, Site = USA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.676 0.766 17.1 -0.883 0.3896   
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger

**FLE ~ Site*Year*Treatment + Species + (1|PlotPair) + (1|Plot\_ID) + (1|Subplot\_ID), data = year)**

## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients

## boundary (singular) fit: see ?isSingular

## Missing cells for: SiteALP:TreatmentEarly, SiteALP:Year2017:TreatmentEarly, SiteALP:Year2018:TreatmentEarly.   
## Interpret type III hypotheses with care.

## Type III Analysis of Variance Table with Kenward-Roger's method  
## Sum Sq Mean Sq NumDF DenDF F value Pr(>F)   
## Site 5169 1292.2 4 19.43 17.0393 3.797e-06 \*\*\*  
## Year 27993 27993.4 1 1137.82 372.7009 < 2.2e-16 \*\*\*  
## Treatment 147 147.2 1 8.97 1.9599 0.19513   
## Species 302520 3980.5 76 1115.86 52.9865 < 2.2e-16 \*\*\*  
## Site:Year 10353 2588.3 4 1133.21 34.4604 < 2.2e-16 \*\*\*  
## Site:Treatment 26 8.7 3 8.32 0.1149 0.94895   
## Year:Treatment 461 461.4 1 1135.36 6.1436 0.01333 \*   
## Site:Year:Treatment 408 136.1 3 1128.59 1.8122 0.14314   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## $emmeans  
## Site = ALP, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 22.1 1.63 145.2 18.9 25.3  
## 2018 23.4 1.63 119.2 20.2 26.6  
##   
## Site = LM, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 26.1 1.50 105.5 23.1 29.1  
## 2018 46.3 1.63 137.4 43.1 49.5  
##   
## Site = LSA, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 29.2 1.26 55.8 26.6 31.7  
## 2018 35.0 1.21 46.4 32.6 37.4  
##   
## Site = UM, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 28.4 1.28 59.2 25.9 31.0  
## 2018 42.1 1.32 65.9 39.5 44.7  
##   
## Site = USA, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 23.3 1.56 125.2 20.2 26.4  
## 2018 26.0 1.39 82.4 23.2 28.8  
##   
## Site = ALP, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 nonEst NA NA NA NA  
## 2018 nonEst NA NA NA NA  
##   
## Site = LM, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 25.0 1.56 125.6 21.9 28.0  
## 2018 48.3 1.44 84.9 45.4 51.2  
##   
## Site = LSA, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 30.0 1.27 57.6 27.4 32.5  
## 2018 36.7 1.21 46.5 34.2 39.1  
##   
## Site = UM, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 28.9 1.23 50.1 26.4 31.4  
## 2018 42.8 1.31 65.5 40.2 45.4  
##   
## Site = USA, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 20.9 1.40 84.1 18.1 23.7  
## 2018 30.1 1.30 63.3 27.5 32.7  
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger   
## Confidence level used: 0.95   
##   
## $contrasts  
## Site = ALP, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -1.32 1.81 1133 -0.731 0.4649   
##   
## Site = LM, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -20.19 1.85 1125 -10.894 <.0001   
##   
## Site = LSA, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -5.82 1.38 935 -4.228 <.0001   
##   
## Site = UM, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -13.69 1.45 1123 -9.416 <.0001   
##   
## Site = USA, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -2.73 1.62 1126 -1.692 0.0910   
##   
## Site = ALP, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 nonEst NA NA NA NA   
##   
## Site = LM, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -23.34 1.73 952 -13.517 <.0001   
##   
## Site = LSA, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -6.68 1.39 1105 -4.821 <.0001   
##   
## Site = UM, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -13.92 1.43 1111 -9.718 <.0001   
##   
## Site = USA, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -9.19 1.44 1104 -6.364 <.0001   
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger

## $emmeans  
## Year = 2017, Site = ALP:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 22.1 1.63 145.2 18.9 25.3  
## Early nonEst NA NA NA NA  
##   
## Year = 2018, Site = ALP:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 23.4 1.63 119.2 20.2 26.6  
## Early nonEst NA NA NA NA  
##   
## Year = 2017, Site = LM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 26.1 1.50 105.5 23.1 29.1  
## Early 25.0 1.56 125.6 21.9 28.0  
##   
## Year = 2018, Site = LM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 46.3 1.63 137.4 43.1 49.5  
## Early 48.3 1.44 84.9 45.4 51.2  
##   
## Year = 2017, Site = LSA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 29.2 1.26 55.8 26.6 31.7  
## Early 30.0 1.27 57.6 27.4 32.5  
##   
## Year = 2018, Site = LSA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 35.0 1.21 46.4 32.6 37.4  
## Early 36.7 1.21 46.5 34.2 39.1  
##   
## Year = 2017, Site = UM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 28.4 1.28 59.2 25.9 31.0  
## Early 28.9 1.23 50.1 26.4 31.4  
##   
## Year = 2018, Site = UM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 42.1 1.32 65.9 39.5 44.7  
## Early 42.8 1.31 65.5 40.2 45.4  
##   
## Year = 2017, Site = USA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 23.3 1.56 125.2 20.2 26.4  
## Early 20.9 1.40 84.1 18.1 23.7  
##   
## Year = 2018, Site = USA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 26.0 1.39 82.4 23.2 28.8  
## Early 30.1 1.30 63.3 27.5 32.7  
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger   
## Confidence level used: 0.95   
##   
## $contrasts  
## Year = 2017, Site = ALP:  
## contrast estimate SE df t.ratio p.value  
## Control - Early nonEst NA NA NA NA   
##   
## Year = 2018, Site = ALP:  
## contrast estimate SE df t.ratio p.value  
## Control - Early nonEst NA NA NA NA   
##   
## Year = 2017, Site = LM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 1.151 1.78 59.7 0.646 0.5206   
##   
## Year = 2018, Site = LM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -1.998 1.76 52.3 -1.133 0.2622   
##   
## Year = 2017, Site = LSA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.827 1.42 24.3 -0.584 0.5646   
##   
## Year = 2018, Site = LSA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -1.687 1.35 19.5 -1.252 0.2253   
##   
## Year = 2017, Site = UM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.471 1.38 20.7 -0.342 0.7360   
##   
## Year = 2018, Site = UM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.698 1.51 31.4 -0.463 0.6464   
##   
## Year = 2017, Site = USA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 2.398 1.67 46.8 1.438 0.1570   
##   
## Year = 2018, Site = USA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -4.057 1.40 23.9 -2.888 0.0081   
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger

**FOF ~ Site*Year*Treatment + Species + (1|PlotPair) + (1|Plot\_ID) + (1|Subplot\_ID), data = year)**

## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients

## Missing cells for: SiteALP:TreatmentEarly, SiteALP:Year2017:TreatmentEarly, SiteALP:Year2018:TreatmentEarly.   
## Interpret type III hypotheses with care.

## Type III Analysis of Variance Table with Kenward-Roger's method  
## Sum Sq Mean Sq NumDF DenDF F value Pr(>F)   
## Site 2658 665 4 16.42 2.9590 0.05152 .   
## Year 33240 33240 1 1060.87 148.9631 < 2.2e-16 \*\*\*  
## Treatment 149 149 1 11.33 0.6694 0.43014   
## Species 164756 2226 74 1047.53 9.9762 < 2.2e-16 \*\*\*  
## Site:Year 7218 1805 4 1056.98 8.0868 2.013e-06 \*\*\*  
## Site:Treatment 629 210 3 9.51 0.9348 0.46124   
## Year:Treatment 11 11 1 1061.96 0.0510 0.82143   
## Site:Year:Treatment 6 2 3 1055.74 0.0088 0.99886   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## $emmeans  
## Site = ALP, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 16.7 2.97 55.7 10.74 22.6  
## 2018 25.8 3.04 56.9 19.73 31.9  
##   
## Site = LM, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 10.0 2.91 51.5 4.19 15.9  
## 2018 32.2 4.36 224.9 23.59 40.8  
##   
## Site = LSA, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 26.3 2.48 28.0 21.27 31.4  
## 2018 35.4 2.73 40.8 29.94 41.0  
##   
## Site = UM, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 19.7 2.47 27.4 14.69 24.8  
## 2018 34.5 2.78 43.9 28.92 40.1  
##   
## Site = USA, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 23.8 2.87 49.8 17.98 29.5  
## 2018 28.4 2.71 39.3 22.89 33.9  
##   
## Site = ALP, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 nonEst NA NA NA NA  
## 2018 nonEst NA NA NA NA  
##   
## Site = LM, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 11.6 3.04 62.0 5.57 17.7  
## 2018 34.5 3.21 73.4 28.08 40.9  
##   
## Site = LSA, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 24.2 2.51 29.5 19.03 29.3  
## 2018 33.9 2.84 47.5 28.19 39.6  
##   
## Site = UM, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 22.5 2.42 25.0 17.54 27.5  
## 2018 37.2 2.94 54.2 31.35 43.1  
##   
## Site = USA, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 24.3 2.71 39.5 18.79 29.8  
## 2018 29.5 2.65 36.4 24.13 34.9  
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger   
## Confidence level used: 0.95   
##   
## $contrasts  
## Site = ALP, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -9.13 2.84 1052 -3.215 0.0013   
##   
## Site = LM, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -22.15 4.42 1051 -5.008 <.0001   
##   
## Site = LSA, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -9.10 2.61 807 -3.492 0.0005   
##   
## Site = UM, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -14.79 2.57 1059 -5.755 <.0001   
##   
## Site = USA, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -4.62 2.59 1043 -1.784 0.0747   
##   
## Site = ALP, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 nonEst NA NA NA NA   
##   
## Site = LM, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -22.84 3.35 960 -6.822 <.0001   
##   
## Site = LSA, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -9.74 2.72 1041 -3.582 0.0004   
##   
## Site = UM, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -14.72 2.73 1047 -5.384 <.0001   
##   
## Site = USA, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -5.23 2.43 1035 -2.154 0.0315   
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger

## $emmeans  
## Year = 2017, Site = ALP:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 16.7 2.97 55.7 10.74 22.6  
## Early nonEst NA NA NA NA  
##   
## Year = 2018, Site = ALP:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 25.8 3.04 56.9 19.73 31.9  
## Early nonEst NA NA NA NA  
##   
## Year = 2017, Site = LM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 10.0 2.91 51.5 4.19 15.9  
## Early 11.6 3.04 62.0 5.57 17.7  
##   
## Year = 2018, Site = LM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 32.2 4.36 224.9 23.59 40.8  
## Early 34.5 3.21 73.4 28.08 40.9  
##   
## Year = 2017, Site = LSA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 26.3 2.48 28.0 21.27 31.4  
## Early 24.2 2.51 29.5 19.03 29.3  
##   
## Year = 2018, Site = LSA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 35.4 2.73 40.8 29.94 41.0  
## Early 33.9 2.84 47.5 28.19 39.6  
##   
## Year = 2017, Site = UM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 19.7 2.47 27.4 14.69 24.8  
## Early 22.5 2.42 25.0 17.54 27.5  
##   
## Year = 2018, Site = UM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 34.5 2.78 43.9 28.92 40.1  
## Early 37.2 2.94 54.2 31.35 43.1  
##   
## Year = 2017, Site = USA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 23.8 2.87 49.8 17.98 29.5  
## Early 24.3 2.71 39.5 18.79 29.8  
##   
## Year = 2018, Site = USA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 28.4 2.71 39.3 22.89 33.9  
## Early 29.5 2.65 36.4 24.13 34.9  
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger   
## Confidence level used: 0.95   
##   
## $contrasts  
## Year = 2017, Site = ALP:  
## contrast estimate SE df t.ratio p.value  
## Control - Early nonEst NA NA NA NA   
##   
## Year = 2018, Site = ALP:  
## contrast estimate SE df t.ratio p.value  
## Control - Early nonEst NA NA NA NA   
##   
## Year = 2017, Site = LM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -1.614 3.18 45.3 -0.508 0.6140   
##   
## Year = 2018, Site = LM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -2.303 4.55 155.4 -0.507 0.6132   
##   
## Year = 2017, Site = LSA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 2.182 2.45 16.1 0.892 0.3854   
##   
## Year = 2018, Site = LSA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 1.541 3.00 35.7 0.515 0.6100   
##   
## Year = 2017, Site = UM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -2.778 2.31 12.4 -1.202 0.2517   
##   
## Year = 2018, Site = UM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -2.710 3.11 41.4 -0.870 0.3892   
##   
## Year = 2017, Site = USA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.523 2.75 25.9 -0.190 0.8507   
##   
## Year = 2018, Site = USA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -1.136 2.51 17.9 -0.453 0.6558   
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger

**FLCC ~ Site*Year*Treatment + Species + (1|PlotPair) + (1|Plot\_ID) + (1|Subplot\_ID), data = year)**

## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients

## Missing cells for: SiteALP:TreatmentEarly, SiteALP:Year2017:TreatmentEarly, SiteALP:Year2018:TreatmentEarly.   
## Interpret type III hypotheses with care.

## Type III Analysis of Variance Table with Kenward-Roger's method  
## Sum Sq Mean Sq NumDF DenDF F value Pr(>F)   
## Site 24350 6087.5 4 15.06 29.6338 5.583e-07 \*\*\*  
## Year 4936 4935.9 1 1273.02 24.2953 9.353e-07 \*\*\*  
## Treatment 95 95.2 1 8.71 0.4686 0.5114   
## Species 173036 2218.4 78 1254.92 10.9193 < 2.2e-16 \*\*\*  
## Site:Year 125089 31272.2 4 1264.37 153.9244 < 2.2e-16 \*\*\*  
## Site:Treatment 1305 434.9 3 8.65 2.1403 0.1678   
## Year:Treatment 284 284.1 1 1271.39 1.3986 0.2372   
## Site:Year:Treatment 62 20.6 3 1263.77 0.1015 0.9592   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## $emmeans  
## Site = ALP, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 38.2 3.24 42.2 31.7 44.8  
## 2018 59.0 3.33 46.0 52.3 65.7  
##   
## Site = LM, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 87.2 3.11 35.9 80.9 93.5  
## 2018 67.3 3.99 93.9 59.4 75.2  
##   
## Site = LSA, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 83.2 2.90 27.2 77.3 89.2  
## 2018 70.9 3.04 33.0 64.7 77.1  
##   
## Site = UM, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 96.3 2.86 25.9 90.5 102.2  
## 2018 67.7 3.07 34.3 61.4 73.9  
##   
## Site = USA, Treatment = Control:  
## Year emmean SE df lower.CL upper.CL  
## 2017 37.4 3.10 35.8 31.1 43.7  
## 2018 58.4 3.05 33.2 52.2 64.6  
##   
## Site = ALP, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 nonEst NA NA NA NA  
## 2018 nonEst NA NA NA NA  
##   
## Site = LM, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 83.8 3.18 38.9 77.4 90.2  
## 2018 66.3 3.14 35.2 59.9 72.7  
##   
## Site = LSA, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 84.2 2.91 27.9 78.2 90.2  
## 2018 72.6 3.07 34.4 66.3 78.8  
##   
## Site = UM, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 91.9 2.84 25.2 86.0 97.7  
## 2018 66.3 3.10 35.6 60.1 72.6  
##   
## Site = USA, Treatment = Early:  
## Year emmean SE df lower.CL upper.CL  
## 2017 45.2 3.04 33.1 39.0 51.4  
## 2018 68.3 2.97 30.0 62.2 74.4  
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger   
## Confidence level used: 0.95   
##   
## $contrasts  
## Site = ALP, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -20.8 2.67 1253 -7.771 <.0001   
##   
## Site = LM, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 19.9 3.55 1249 5.612 <.0001   
##   
## Site = LSA, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 12.3 2.37 1019 5.189 <.0001   
##   
## Site = UM, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 28.7 2.21 1245 12.988 <.0001   
##   
## Site = USA, Treatment = Control:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -20.9 2.32 1238 -9.041 <.0001   
##   
## Site = ALP, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 nonEst NA NA NA NA   
##   
## Site = LM, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 17.5 2.79 967 6.280 <.0001   
##   
## Site = LSA, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 11.6 2.30 1241 5.064 <.0001   
##   
## Site = UM, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 25.5 2.26 1252 11.280 <.0001   
##   
## Site = USA, Treatment = Early:  
## contrast estimate SE df t.ratio p.value  
## 2017 - 2018 -23.1 2.20 1241 -10.500 <.0001   
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger

## $emmeans  
## Year = 2017, Site = ALP:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 38.2 3.24 42.2 31.7 44.8  
## Early nonEst NA NA NA NA  
##   
## Year = 2018, Site = ALP:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 59.0 3.33 46.0 52.3 65.7  
## Early nonEst NA NA NA NA  
##   
## Year = 2017, Site = LM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 87.2 3.11 35.9 80.9 93.5  
## Early 83.8 3.18 38.9 77.4 90.2  
##   
## Year = 2018, Site = LM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 67.3 3.99 93.9 59.4 75.2  
## Early 66.3 3.14 35.2 59.9 72.7  
##   
## Year = 2017, Site = LSA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 83.2 2.90 27.2 77.3 89.2  
## Early 84.2 2.91 27.9 78.2 90.2  
##   
## Year = 2018, Site = LSA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 70.9 3.04 33.0 64.7 77.1  
## Early 72.6 3.07 34.4 66.3 78.8  
##   
## Year = 2017, Site = UM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 96.3 2.86 25.9 90.5 102.2  
## Early 91.9 2.84 25.2 86.0 97.7  
##   
## Year = 2018, Site = UM:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 67.7 3.07 34.3 61.4 73.9  
## Early 66.3 3.10 35.6 60.1 72.6  
##   
## Year = 2017, Site = USA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 37.4 3.10 35.8 31.1 43.7  
## Early 45.2 3.04 33.1 39.0 51.4  
##   
## Year = 2018, Site = USA:  
## Treatment emmean SE df lower.CL upper.CL  
## Control 58.4 3.05 33.2 52.2 64.6  
## Early 68.3 2.97 30.0 62.2 74.4  
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger   
## Confidence level used: 0.95   
##   
## $contrasts  
## Year = 2017, Site = ALP:  
## contrast estimate SE df t.ratio p.value  
## Control - Early nonEst NA NA NA NA   
##   
## Year = 2018, Site = ALP:  
## contrast estimate SE df t.ratio p.value  
## Control - Early nonEst NA NA NA NA   
##   
## Year = 2017, Site = LM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 3.417 4.15 13.69 0.822 0.4249   
##   
## Year = 2018, Site = LM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 1.038 4.79 23.70 0.217 0.8303   
##   
## Year = 2017, Site = LSA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -0.975 3.87 10.34 -0.252 0.8059   
##   
## Year = 2018, Site = LSA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -1.655 4.08 12.81 -0.406 0.6918   
##   
## Year = 2017, Site = UM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 4.439 3.79 9.55 1.172 0.2697   
##   
## Year = 2018, Site = UM:  
## contrast estimate SE df t.ratio p.value  
## Control - Early 1.313 4.12 13.26 0.319 0.7546   
##   
## Year = 2017, Site = USA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -7.777 4.03 12.24 -1.929 0.0772   
##   
## Year = 2018, Site = USA:  
## contrast estimate SE df t.ratio p.value  
## Control - Early -9.949 3.94 11.14 -2.526 0.0279   
##   
## Results are averaged over the levels of: Species   
## Degrees-of-freedom method: kenward-roger