**RESULTS** (tables are included just as references to report)

Elements of forest pyrolysis, an absence of fire in non-contiguous forests, elevation gradients and soil and foliar chemistry continue to play a role in an enigmatic response of pitch pine trees located in and outside a 1947 fire footprint on Mt. Desert island.

***Allometric Data***

Response, either as growth or stress resistance was discernable in trees from burned and unburned stands; they differed significantly in Tukey’s tests according to height growth (*P*=0.031), canopy width (*P*=0.035) and dbh (*P*=0.001). Individuals along Cadillac South ridge trail were substantially shorter, narrower in canopy and smaller in dbh than their three counterparts (Table 1). We assumed trees at lower unburned elevations would deport more substantial allometric gains based on a lack of environmental stressors which would be more likely to depress growth at higher elevations—this was confirmed. (Maybe these become three figure panels)

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TABLE 1. Results from analysis of variance (ANOVA) for plant height, canopy (span)** | | | | | | | | | | |
|  | **and diameter (at breast height)** | | | | |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | Height (cm) |  | Canopy (cm) | | DBH (cm) | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | df | F | P | F | P | F | P |  |  |  |
| Sites | 3 | 3.3319 | **0.03** | 3.1881 | **0.035** | 6.8211 | **<0.001** |  |  |  |
| Residuals | 36 |  |  |  |  |  |  |  |  |  |

***Foliar C, δ13C and N Data***

Elevation gradients, growth and stress resistance were highlighted also according to foliar C availability and δ13C (iWUEisotope) response (Table 2).Strictly on a percentage basis foliar C was more substantial in burned as opposed to unburned communities resulting in marginally significant outcomes (*P*=0.055). The most robust iWUEisotope response was found among trees at higher elevation St. Sauveur trail (-27.0‰) consistent with depleted C. Grouped together, burned trees along South Cadillac trail (-27.4‰) and Cadillac cliffs (-28.4‰) expressed a significantly different δ13C from their unburned cohorts (*P*=0.004). We anticipated a correlation between allometrics, foliar C and iWUEisotope and, for the most part, that result materialized. We further conjectured differences in foliar N recalcitrancewould be minimal; in fact there was <5% difference in N availability among the populations and δ15N was not a factor. Foliar C/N ratios were not significantly different (*P*>.05).

***Foliar nutrient Data***

Foliar mineral availability was significantly different between burned and unburned trees—Ca (*P*<0.001), P (*P*=0.032), K (*P*<0.001) and Zn (*P*<0.008) (Table 3)—split between a group advantage for unburned and some individually higher minerals (P, K and Mg) at Cadillac cliffs where we interpret elevation played a much larger role than pyrolysis recalcitrance. Mg and Al contributions were not statistically different (*P*>0.05). Despite finding substantially greater P

availability at Cadillac cliffs, it along with N, did not factor into growth in comparison with trees at another low elevation (Wonderland).

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| **Table 3. Results of Analysis of Variance (ANOVA) for foliar mineral nutrient** | | |  |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | | |  |  |  |  |  |  |  |  |  |  |  | |  |  | Ca |  | P |  | K |  | Mg |  | Al |  | Zn |  | |  | df | F | P | F | P | F | P | F | P | F | P | F | P | | Sites | 3 | 6.623 | **0.001** | 3.198 | **0.032** | 6.825 | **0.001** | 2.0252 | >.05 | 0.102 | >.05 | 4.456 | **0.008** | | Residuals | 37 |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |

***Soil organic Data***

Soil C concentration was approximately two times greater at Wonderland and St. Sauveur (*m*=24.5%) trails compared to those at South Cadillac trail and Cadillac Cliffs (*m*=13.2%) with Wonderland three times higher than South Cadillac trail (Table 4). These data correspond to significant differences between burned and unburned precincts (*P*=0.023). Except for a lower soil N at South Cadillac trail (.28%) compared to the others (.51%), there was no significant difference (*P*>.05) in soil N between groups. However, in the case of soil C/N, differences were statistically significant (*P*=.039), owing to a greater disparity in C contributions amongst tree groups.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TABLE 4. Results from analysis of variance (ANOVA) for soil C and N nutrient** | | | | | | | | | | | | | | | | | | | | | | |
|  | |  | |  | | |  | | |  | | | |  | |  | | |  | | |  |
|  | | |  | | |  | | |  | | |  | | |  | |
|  | C | | | |  | | | N | | |  | | C/N | | | | |  | |  |
|  | | df | | F | | | P | | | F | | | | P | | F | | | P | | |  |
| Sites | | 3 | | 3.726 | | | **0.023** | | | 0.7197 | | | | >.05 | | 3.2896 | | | **0.039** | | |  |

***Soil mineral Data***

Elevation gradients discriminated presence or absence of soil minerals; we found St. Sauveur and Wonderland, unburned populations, collectively held greater Ca, P and Mg amounts but only K (*P*=0.019) and Al (*P*=0.027) were statistically more significant (Table 5). Noticeably higher P at Wonderland was consistent with higher growth output compared to the other sites.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TABLE 5. Results from analysis of variance (ANOVA) for soil mineral nutrient** | | | | | | | | |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | | |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Ca |  | P |  | K |  | Mg |  | Al |  | Zn |  |
|  | df | F | P | F | P | F | P | F | P | F | P | F | P |
| Sites | 3 | 2.691 | >.05 | 1.753 | >.05 | 3.908 | **0.019** | 1.234 | >.05 | 3.564 | **0.027** | 1.536 | >.05 |
| Residuals | 37 |  |  |  |  |  |  |  |  |  |  |  |  |

***Soil moisture retention Data* (maybe this becomes a figure panel depending on how stark it looks)**

In the stressed environment on Mt. Desert, soil moisture retention, especially during peak PAR (photosynthetic active radiation) months, is crucial to survival in competition with other, larger evergreens indirectly sharing the same moisture resources. In a previous paper, investigators (Licht and Smith 2020) examined moisture retention in a controlled study of pitch pine exposed to natural and prescribed fire treatments with the result that charcoal PyC effects were found to add considerably to water retention outcomes. At Mt. Desert, though soils are glaciated as opposed to sandy or gravelly, and though no surface and very little subsurface charcoal was identified (compared to reports by Laird in 1993), we used the same methods as the earlier investigation to study recalcitrant effects of wildfire charcoal derived from the mid-twentieth century conflagration. At Cadillac cliffs, although not at South Cadillac trail, moisture retention was reflective of a significant level of soil C (*P*<0.0001), which was not attributed to fire event recalcitrance but, interestingly, 45% greater than its nearest unburned cohort, St. Sauveur. We subscribe to a theory that higher C at Cadillac cliffs and Wonderland is likely due to greater organic detritus and decomposition.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TABLE 6. Results from analysis of variance (ANOVA) soil water retention** | | | | | | | | |
|  |  |  |  |  |  |  |  |  |
| Water retention | | df | F | P |  |  |  |  |
| Sites |  | 3 | 9.671 | **<0.001** |  |  |  |  |
| Residuals |  | 36 |  |  |  |  |  |  |

Nick: Given your comments about the complexities of attributing causal effects to topographical differences, I merely include the table below independent of any analysis. I gather (I of course do not have any experience with modeling as you do) depending on variation in scale between response variables and explanatory variables that if there is not a high degree of correlation within each group of samples that there is more to exploit. I have chosen the explanatory path but others might choose to create a predictive model which suggests what will happen to pines in either the post-fire or never-fire categories. For example, Cadillac cliffs and St. Sauveur appear to have predominantly similar aspect and compass if not slope characteristics. I do find it somewhat interesting that compass direction is so scattered for two populations as opposed to the others (one each in terms of the elevation gradient). I am totally at sea when it comes to deciphering these and recognize that our sample is small enough so that there may not be any real value in tackling this set of data (apparently there are spatial autocorrelation errors which I may engender trying to achieve some explanation). In another paper, if we can get to it, we may find the sympatry at Cadillac provides a chance to combine our data on pitch and jack pine there with other, non-coastal data in other states or Canada with which to develop a predictive model which has some reliability.

**TABLE 7. Geo- and topographic data**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ID | Name | x | y | Label | Elevation | Slope | Aspect | Compass |
|  |  |  |  |  |  |  |  |  |
| PP1 | CAD | -68.218785 | 44.325946 | PP1 | 205 | 20 | 19 | North |
| PP2 | CAD | -68.222364 | 44.331892 | PP2 | 277 | 10 | 80 | East |
| PP3 | CAD | -68.222701 | 44.331704 | PP3 | 279 | 5 | 150 | SE |
| PP4 | CAD | -68.222806 | 44.329033 | PP4 | 216 | 23 | 198 | South |
| PP5 | CAD | -68.222848 | 44.332203 | PP5 | 284 | 10 | 94 | East |
| PP6 | CAD | -68.220520 | 44.326652 | PP6 | 217 | 10 | 201 | South |
| PP7 | CAD | -68.220144 | 44.326079 | PP7 | 212 | 2 | 74 | East |
| PP8 | CAD | -68.219955 | 44.326558 | PP8 | 211 | 10 | 120 | SE |
| PP9 | CAD | -68.222839 | 44.331599 | PP9 | 278 | 10 | 162 | South |
| PP10 | CAD | -68.220191 | 44.326505 | PP10 | 214 | 5 | 173 | South |
| PP1 | CADCLIFFS | -68.184994 | 44.327785 | PP1 | 29 | 18 | 120 | SE |
| PP2 | CADCLIFFS | -68.184909 | 44.327839 | PP2 | 28 | 15 | 115 | SE |
| PP3 | CADCLIFFS | -68.185274 | 44.327835 | PP3 | 32 | 14 | 123 | SE |
| PP4 | CADCLIFFS | -68.185045 | 44.327710 | PP4 | 29 | 16 | 129 | SE |
| PP5 | CADCLIFFS | -68.185261 | 44.327888 | PP5 | 33 | 19 | 157 | SE |
| PP6 | CADCLIFFS | -68.185338 | 44.327824 | PP6 | 32 | 9 | 138 | SE |
| PP7 | CADCLIFFS | -68.185424 | 44.327916 | PP7 | 33 | 11 | 185 | South |
| PP8 | CADCLIFFS | -68.185467 | 44.327778 | PP8 | 32 | 19 | 130 | SE |
| PP9 | CADCLIFFS | -68.185617 | 44.327992 | PP9 | 38 | 14 | 80 | East |
| PP10 | CADCLIFFS | -68.185446 | 44.328192 | PP10 | 40 | 32 | 244 | SW |
| PP1 | STSAUV | -68.329148 | 44.311904 | PP1 | 134 | 19 | 314 | NE |
| PP2 | STSAUV | -68.327688 | 44.311331 | PP2 | 159 | 3 | 254 | West |
| PP3 | STSAUV | -68.326502 | 44.310736 | PP3 | 185 | 20 | 275 | West |
| PP4 | STSAUV | -68.326980 | 44.310686 | PP4 | 175 | 20 | 257 | West |
| PP5 | STSAUV | -68.327474 | 44.310921 | PP5 | 163 | 12 | 282 | West |
| PP6 | STSAUV | -68.327431 | 44.310721 | PP6 | 164 | 13 | 251 | West |
| PP7 | STSAUV | -68.326745 | 44.310307 | PP7 | 176 | 12 | 277 | West |
| PP8 | STSAUV | -68.326015 | 44.310230 | PP8 | 180 | 11 | 122 | SE |
| PP9 | STSAUV | -68.324663 | 44.310261 | PP9 | 184 | 17 | 247 | SW |
| PP10 | STSAUV | -68.323976 | 44.310061 | PP10 | 195 | 25 | 237 | SW |
| PP1 | WOND | -68.315257 | 44.231664 | PP1 | 17 | 4 | 287 | West |
| PP2 | WOND | -68.314908 | 44.231531 | PP2 | 18 | 0 | 323 | NE |
| PP3 | WOND | -68.313370 | 44.230862 | PP3 | 12 | 2 | 120 | SE |
| PP4 | WOND | -68.314917 | 44.231479 | PP4 | 18 | 2 | 205 | SW |
| PP5 | WOND | -68.314410 | 44.231365 | PP5 | 17 | 5 | 111 | East |
| PP6 | WOND | -68.314425 | 44.231174 | PP6 | 15 | 3 | 56 | NE |
| PP7 | WOND | -68.315469 | 44.231198 | PP7 | 15 | 3 | 260 | West |
| PP8 | WOND | -68.313625 | 44.231271 | PP8 | 15 | 7 | 100 | East |
| PP9 | WOND | -68.314053 | 44.231347 | PP9 | 16 | 3 | 197 | South |
| PP10 | WOND | -68.313910 | 44.231145 | PP10 | 16 | 5 | 225 | SW |