

## reg\_AIC\_multInteraction

May 7, 2024

```
[1]: # Kristina Fauss
# April 19, 2024
# model selection by AIC testing all 1st order interactions

import warnings
warnings.filterwarnings("ignore")

import pandas as pd
import statsmodels.formula.api as smf

from ols_mixedef_custom import *

[2]: fp = '/Users/kristinafauss/BackupToBox/Git/lab-flammability-testing-2022/data/
      processed-data/main_dataset.csv'

      flamog = pd.read_csv(fp)

      # drop na's for flam metrics
      print(len(flamog))
      for col in ['fh', 'fd', 'pfg', 'temp_change', 'heat_flux_change']:
          flamog.dropna(subset=col, inplace=True)
      print(len(flamog))

      flamog['plant_id']=[str(a)+'_'+str(b) for a,b in zip(flamog['plant'],
      flamog['species'])]

      # report
      print(flamog.columns)
      flamog.head()
```

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```
Index(['Unnamed: 0', 'species', 'plant', 'date', 'total_branch_mass',
      'total_leaf_mass', 'stem_mass_ratio', 'leaf_mass_ratio', 'leaf_lfm',
      'thickness', 'leaf_wet_mass', 'leaf_dry_mass', 'stem_lfm', 'stem_width',
      'stem_wet_mass', 'stem_dry_mass', 'stem_sav', 'lfm', 'leaf_dmc',
      'stem_dmc', 'dmc', 'leaf_area', 'leaf_sav', 'LMA', 'SLA', 'rep',
      'branch_length', 'branch_width', 'branch_height', 'sample_wt',
```

```

'no_branches', 'mpa', 'notes_on_plant_char', 'start_time',
'ambient_temp', 'ambient_humidity', 'pre_ignition_glow',
'first_glow_time', 'ignition', 'primary_ignition',
'primary_time_of_flame_end', 'secondary_ignition',
'secondary_time_of_flame_end', 'third_ignition',
'third_time_of_ignition_flame_end', 'time_fh', 'fh', 'time_of_glow_end',
'end_time', 'thermocoupler_height', 'hotplate_height',
'notes_on_flam_data', 'fd', 'tti', 'pfg', 'max_temp',
'time_at_max_temp', 'max_temp_sensor', 'start_temp',
'start_temp_sensor', 'stable_avg_temp', 'temp_change', 'avg_temp_ch3',
'max_heat_flux_loessCH7', 'time_at_max_heat_flux_loessCH7',
'max_heat_flux_loessCH8', 'time_at_max_heat_flux_loessCH8',
'avg_heat_flux_stableCH7', 'avg_heat_flux_stableCH8',
'heat_flux_change', 'prop_ig', 'wet_mass', 'dry_mass', 'gdw_gfw',
'dw_flam_sample', 'ww_flam_sample', 'branch_volume', 'branching',
'sample_density', 'dw_sppdev', 'plant_id'],
dtype='object')

```

```

[2]: Unnamed: 0 species plant date total_branch_mass total_leaf_mass \
0 1 ARCDEN 1 2022-08-10 20.347 19.505
1 2 ARCDEN 1 2022-08-10 20.347 19.505
2 3 ARCDEN 1 2022-08-10 20.347 19.505
3 4 ARCDEN 1 2022-08-10 20.347 19.505
4 5 ARCDEN 1 2022-08-10 20.347 19.505

stem_mass_ratio leaf_mass_ratio leaf_lfm thickness ... wet_mass \
0 0.510564 0.489436 251.06912 0.514 ... 1.151
1 0.510564 0.489436 251.06912 0.514 ... 1.151
2 0.510564 0.489436 251.06912 0.514 ... 1.151
3 0.510564 0.489436 251.06912 0.514 ... 1.151
4 0.510564 0.489436 251.06912 0.514 ... 1.151

dry_mass gdw_gfw dw_flam_sample ww_flam_sample branch_volume \
0 0.3683 0.242414 1.291195 4.035205 1082.04
1 0.3683 0.242414 1.429372 4.467028 1370.20
2 0.3683 0.242414 1.283923 4.012477 682.04
3 0.3683 0.242414 1.283923 4.012477 1262.25
4 0.3683 0.242414 0.811215 2.535185 819.00

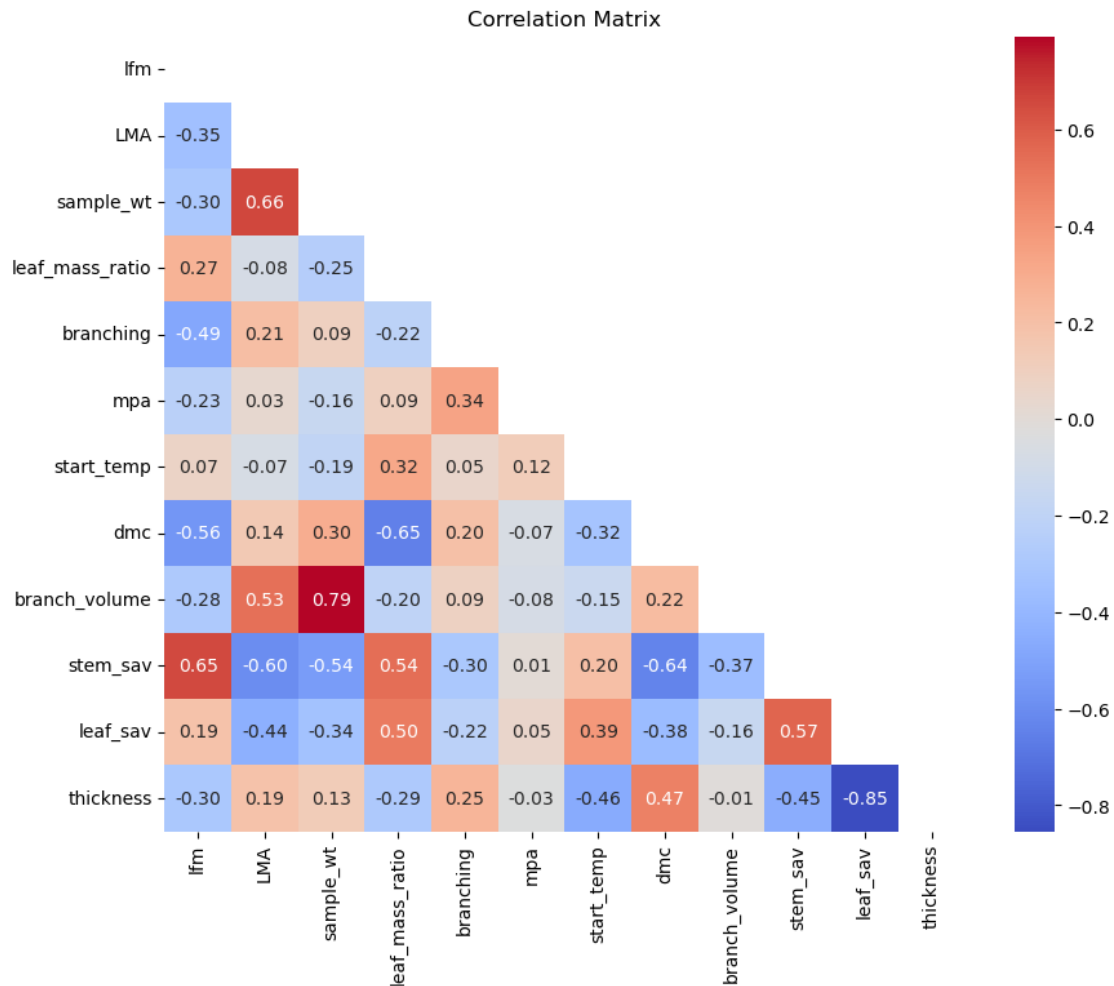
branching sample_density dw_sppdev plant_id
0 0.416667 0.004923 0.923122 1_ARCDEN
1 0.322581 0.004303 1.348152 1_ARCDEN
2 0.294118 0.007766 0.900752 1_ARCDEN
3 0.466667 0.004196 0.900752 1_ARCDEN
4 0.500000 0.004086 -0.553297 1_ARCDEN

```

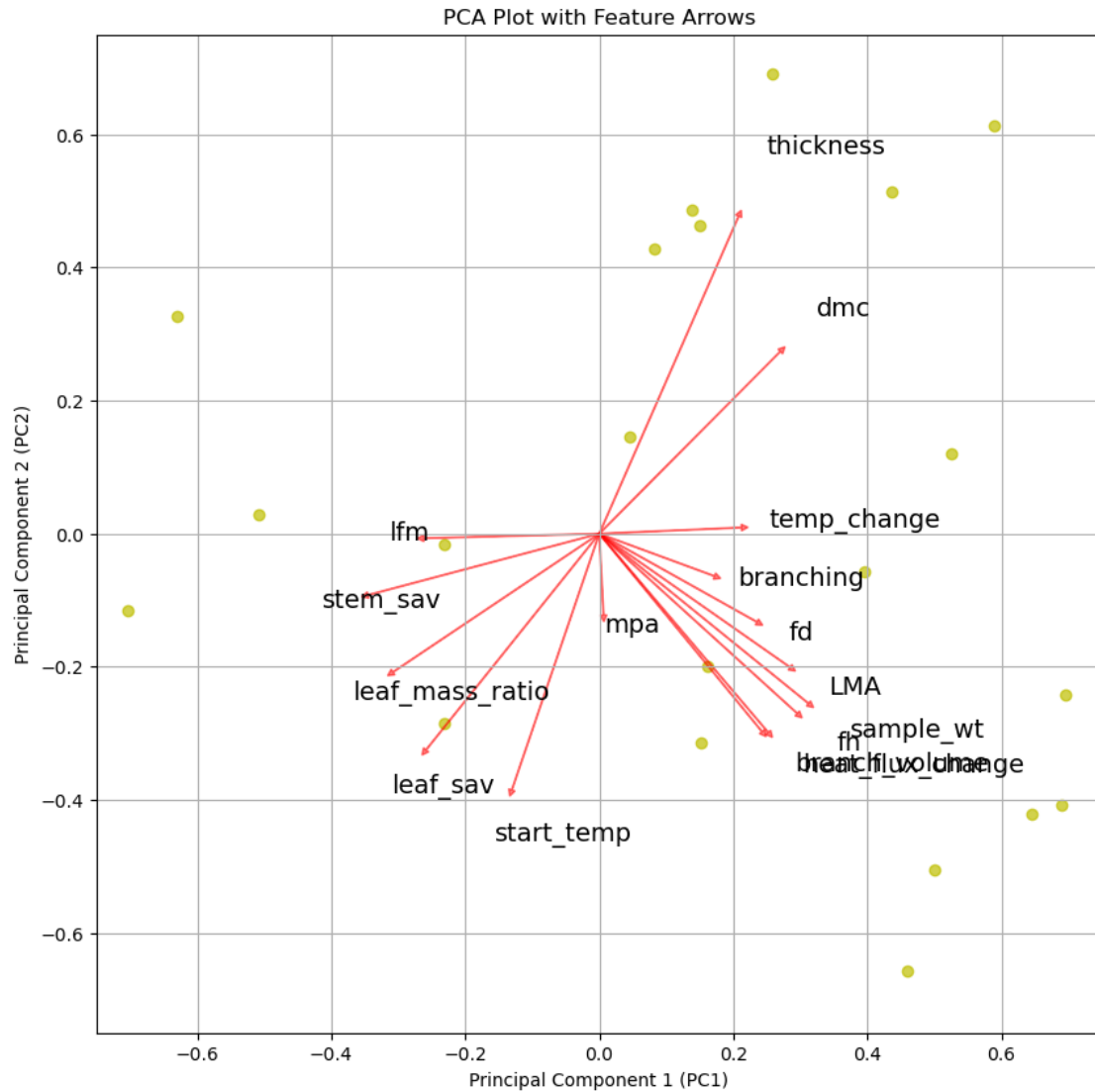
[5 rows x 81 columns]

# 1 Examine Correlation & Structure in Num. Var's

```
[3]: cols_num_use = ['lfm', 'LMA', 'sample_wt', 'leaf_mass_ratio', 'branching',  
    ↪ 'mpa', 'start_temp', 'dmc', 'branch_volume', 'stem_sav', 'leaf_sav',  
    ↪ 'thickness']  
  
corrplot(flamog, cols_num_use)
```



```
[4]: PCAplot(flamog, cols_num_use+['fh', 'fd', 'temp_change', 'heat_flux_change'])
```



## 2 Modeling Preprocessing

```
[5]: # scale and center
cols_all = ['fh', 'fd', 'temp_change', 'heat_flux_change'] + cols_num_use
flam = scale_and_center(flamog, cols_all, cols_no_change=['plant_id', 'species', 'ignition'])

# declare as factors
flam['species'] = pd.Categorical(flam['species'])
flam['plant_id'] = pd.Categorical(flam['plant_id'])
flam['ignition'] = pd.Categorical(flam['ignition'])
```

```

# drop na's
print(len(flam))
cols_all_dpna = cols_all + ['plant_id', 'species', 'ignition']
flam.dropna(subset=cols_all_dpna, inplace=True)
print(len(flam))

# declare all possible IV cols to model
cols_use = cols_num_use #+ ['species']
print(cols_use)

```

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162

```

['lfm', 'LMA', 'sample_wt', 'leaf_mass_ratio', 'branching', 'mpa', 'start_temp',
'dmc', 'branch_volume', 'stem_sav', 'leaf_sav', 'thickness']

```

### 3 Run Model Selector

#### 3.0.1 NOTE: Random effect is simply plant\_id

- NO nested effects
- NO 'species'

It was not possible to test all combinations. Therefore, only combinations of significant interaction terms and all singletons will be tested.

```

[6]: mxs = len(cols_use)
     mns = 1
     mxi = 5
     mni = 1

```

### 4 Flame Height

```

[7]: yvar='fh'
     cols=cols_use
     df=flam

     compare_predictors_mixedeff(df, cols, yvar)

```

	cols	aics	pvals	coefs	top_mod
0	mpa	348.953488	0.020467	7.757524e-01	True
1	leaf_sav	348.840407	-0.044770	6.604181e-01	True
2	thickness	348.832041	-0.040855	6.522019e-01	True
3	dmc	348.510981	0.068659	4.682279e-01	True
4	leaf_mass_ratio	347.832781	-0.120260	2.694377e-01	True
5	start_temp	345.657175	0.133740	6.423671e-02	False
6	lfm	344.576424	-0.306653	3.468785e-02	False
7	stem_sav	344.331290	-0.498367	6.173055e-04	False

8	LMA	341.248709	0.391200	2.603875e-03	False
9	branching	339.713739	0.199225	1.947306e-03	False
10	branch_volume	334.006737	0.253649	6.808868e-05	False
11	sample_wt	306.849369	0.466529	4.664215e-12	False

```
[8]: AIC_iterator(flam, cols_use, Y_VAR='fh',
                 minnumsingle=mns, maxnumsingle=mxs, minnumint=mni, maxnumint=mxi)
```

ERROR: Formula model error: fh ~ leaf\_sav\*thickness

Columns present in sig. interaction terms: {'mpa', 'branching', 'start\_temp', 'sample\_wt'}

Total Num. Cols : Num. Sig. Int. Cols; 12 : 4

Significant Interactions:

('sample\_wt', 'mpa')

('sample\_wt', 'start\_temp')

('sample\_wt', 'branching')

Number of formulas: 4864

```
fh ~ sample_wt*mpa + branching + start_temp + stem_sav
fh ~ sample_wt*mpa + sample_wt*start_temp + branching + stem_sav
fh ~ sample_wt*mpa + sample_wt*branching + start_temp + stem_sav
fh ~ sample_wt*mpa + branching + start_temp + stem_sav + thickness
fh ~ sample_wt*mpa + lfm + branching + start_temp + stem_sav
fh ~ sample_wt*mpa + branching + start_temp + dmc + stem_sav
fh ~ sample_wt*mpa + LMA + branching + start_temp + stem_sav
fh ~ sample_wt*mpa + branching + start_temp + stem_sav + leaf_sav
fh ~ sample_wt*mpa + branching + start_temp + branch_volume + stem_sav
```

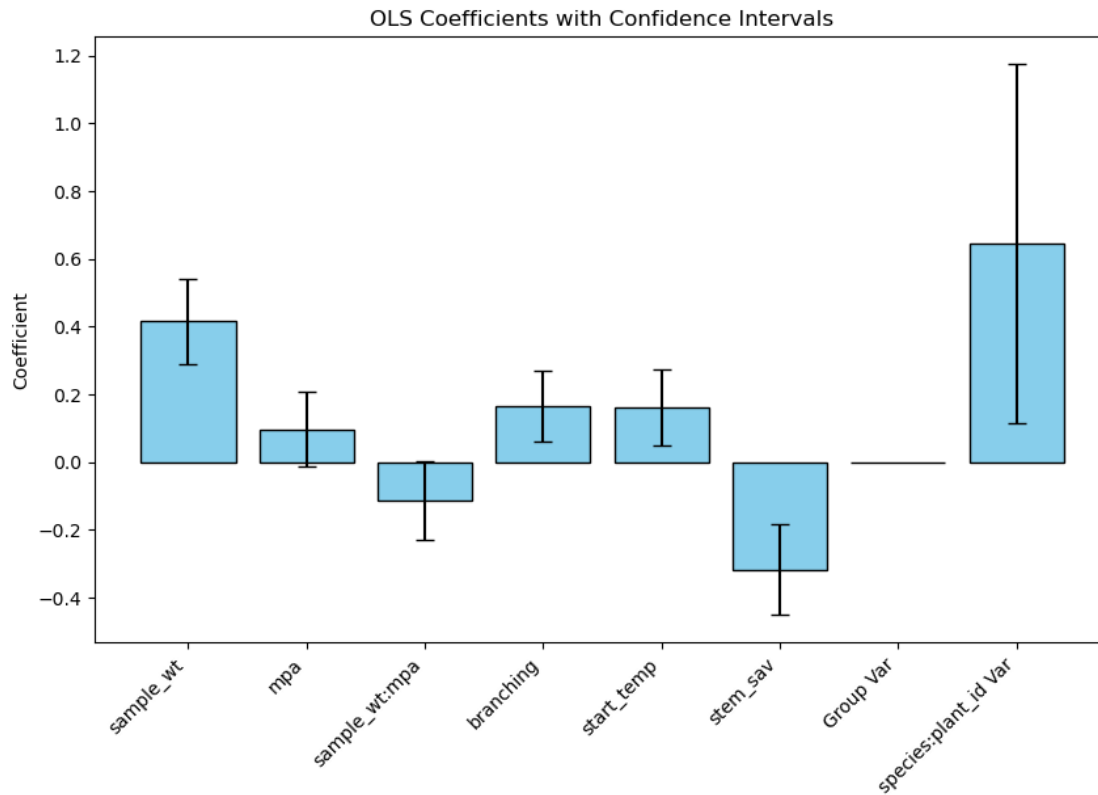
#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM    Dependent Variable:    fh
No. Observations:    162        Method:                ML
No. Groups:          8          Scale:                0.2255
Min. group size:     2          Log-Likelihood:       -135.9798
Max. group size:     37        Converged:            Yes
Mean group size:     20.2

-----
                Coef.  Std.Err.  z    P>|z|  [0.025 0.975]
-----
Intercept      -0.004    0.068  -0.064  0.949  -0.137  0.128
sample_wt       0.415    0.064   6.458  0.000   0.289  0.541
mpa             0.097    0.056   1.731  0.084  -0.013  0.207
```

sample_wt:mpa	-0.114	0.060	-1.914	0.056	-0.231	0.003
branching	0.166	0.054	3.067	0.002	0.060	0.272
start_temp	0.161	0.057	2.831	0.005	0.050	0.273
stem_sav	-0.317	0.068	-4.642	0.000	-0.451	-0.183
Group Var	0.000					
species:plant_id Var	0.145	0.128				

=====



#### Mixed Linear Model Regression Results

=====

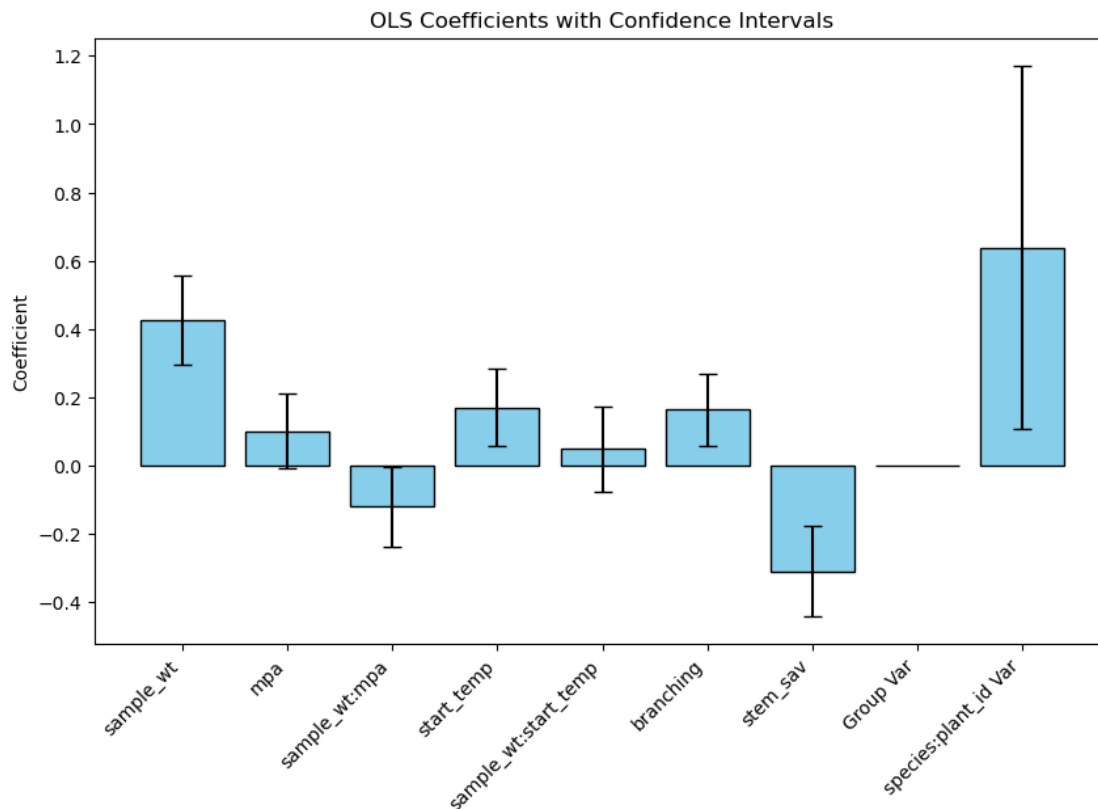
Model:	MixedLM	Dependent Variable:	fh
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.2252
Min. group size:	2	Log-Likelihood:	-135.7150
Max. group size:	37	Converged:	No
Mean group size:	20.2		

-----

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	0.007	0.070	0.104	0.917	-0.129	0.144
sample_wt	0.426	0.066	6.452	0.000	0.296	0.555

mpa	0.100	0.056	1.781	0.075	-0.010	0.211
sample_wt:mpa	-0.120	0.060	-2.005	0.045	-0.238	-0.003
start_temp	0.169	0.058	2.923	0.003	0.056	0.283
sample_wt:start_temp	0.048	0.064	0.740	0.459	-0.079	0.174
branching	0.164	0.054	3.036	0.002	0.058	0.270
stem_sav	-0.310	0.067	-4.637	0.000	-0.441	-0.179
Group Var	0.000					
species:plant_id Var	0.144	0.129				

=====



#### Mixed Linear Model Regression Results

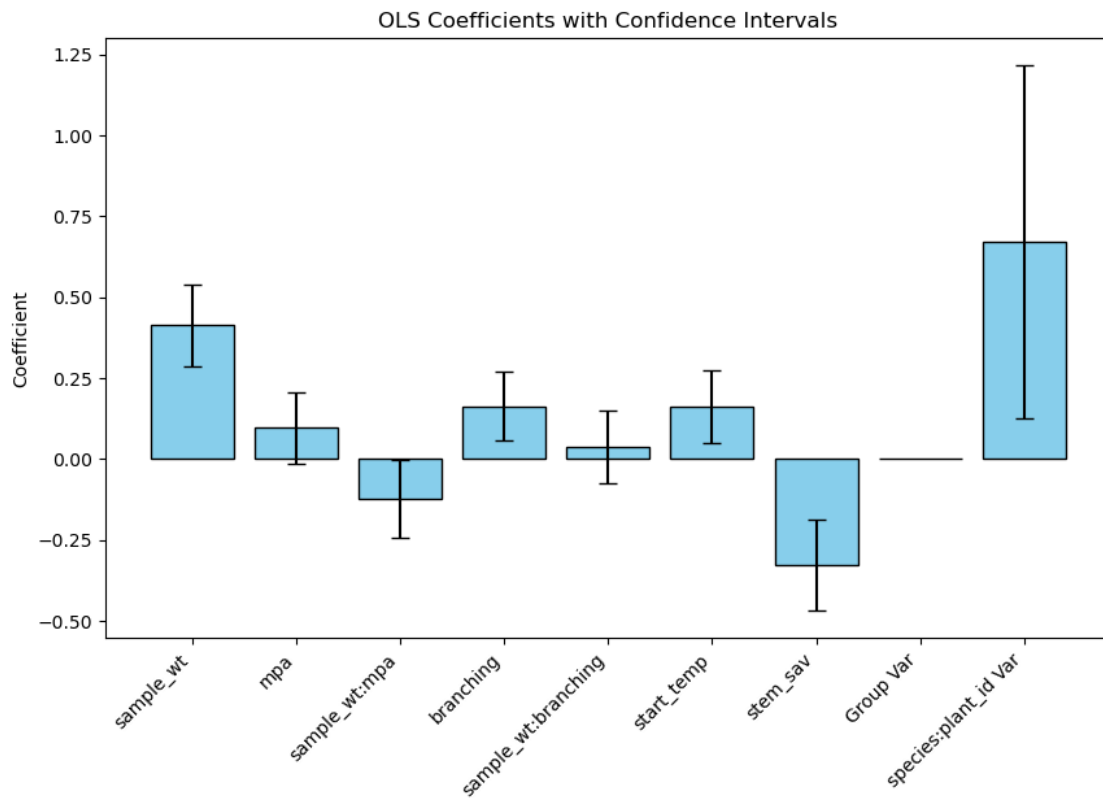
Model:	MixedLM	Dependent Variable:	fh
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.2231
Min. group size:	2	Log-Likelihood:	-135.7836
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

Coef.	Std.Err.	z	P> z	[0.025 0.975]
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Intercept	-0.008	0.069	-0.114	0.910	-0.142	0.127
sample_wt	0.413	0.064	6.424	0.000	0.287	0.540
mpa	0.096	0.056	1.710	0.087	-0.014	0.206
sample_wt:mpa	-0.124	0.061	-2.019	0.043	-0.244	-0.004
branching	0.163	0.054	3.016	0.003	0.057	0.270
sample_wt:branching	0.037	0.058	0.642	0.521	-0.076	0.150
start_temp	0.161	0.057	2.831	0.005	0.050	0.273
stem_sav	-0.328	0.071	-4.614	0.000	-0.468	-0.189
Group Var	0.000					
species:plant_id Var	0.150	0.131				

=====

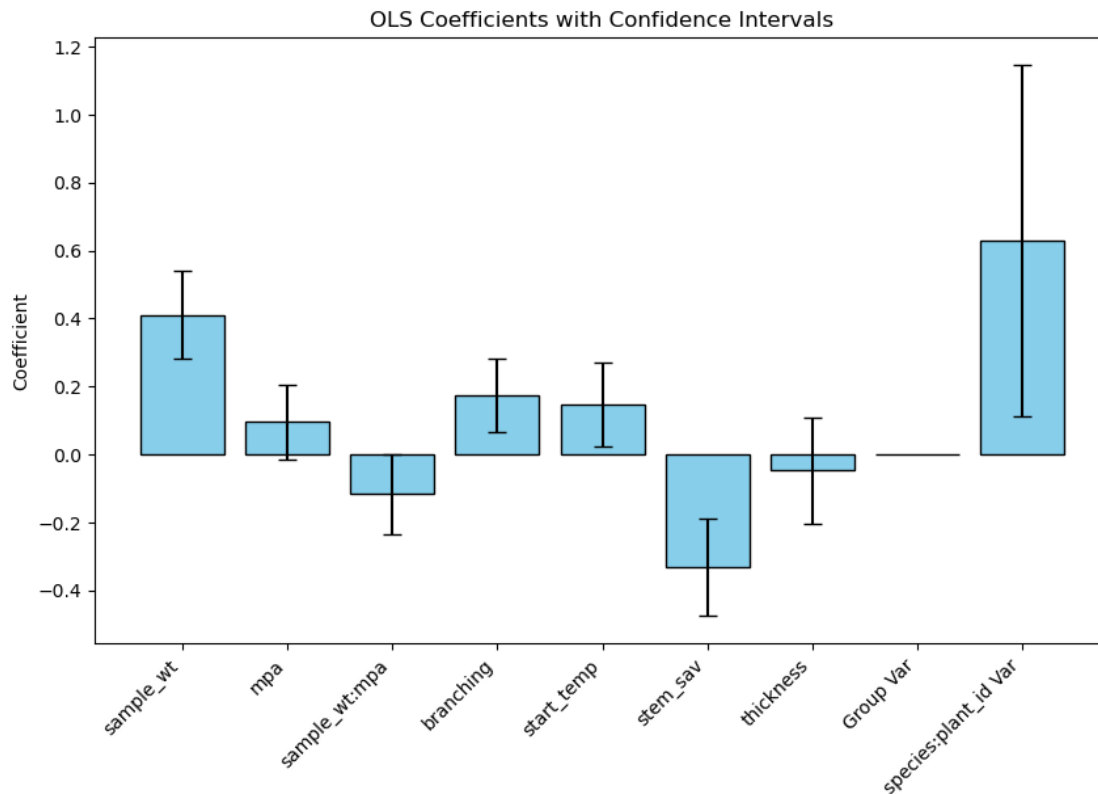


#### Mixed Linear Model Regression Results

Model:	MixedLM	Dependent Variable:	fh
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.2261
Min. group size:	2	Log-Likelihood:	-135.8154
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

-----

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.009	0.068	-0.128	0.898	-0.142	0.124
sample_wt	0.411	0.065	6.282	0.000	0.283	0.539
mpa	0.096	0.056	1.704	0.088	-0.014	0.206
sample_wt:mpa	-0.116	0.060	-1.948	0.051	-0.234	0.001
branching	0.173	0.055	3.126	0.002	0.064	0.281
start_temp	0.146	0.063	2.339	0.019	0.024	0.269
stem_sav	-0.332	0.073	-4.544	0.000	-0.475	-0.189
thickness	-0.047	0.080	-0.585	0.559	-0.203	0.110
Group Var	0.000					
species:plant_id Var	0.142	0.125				

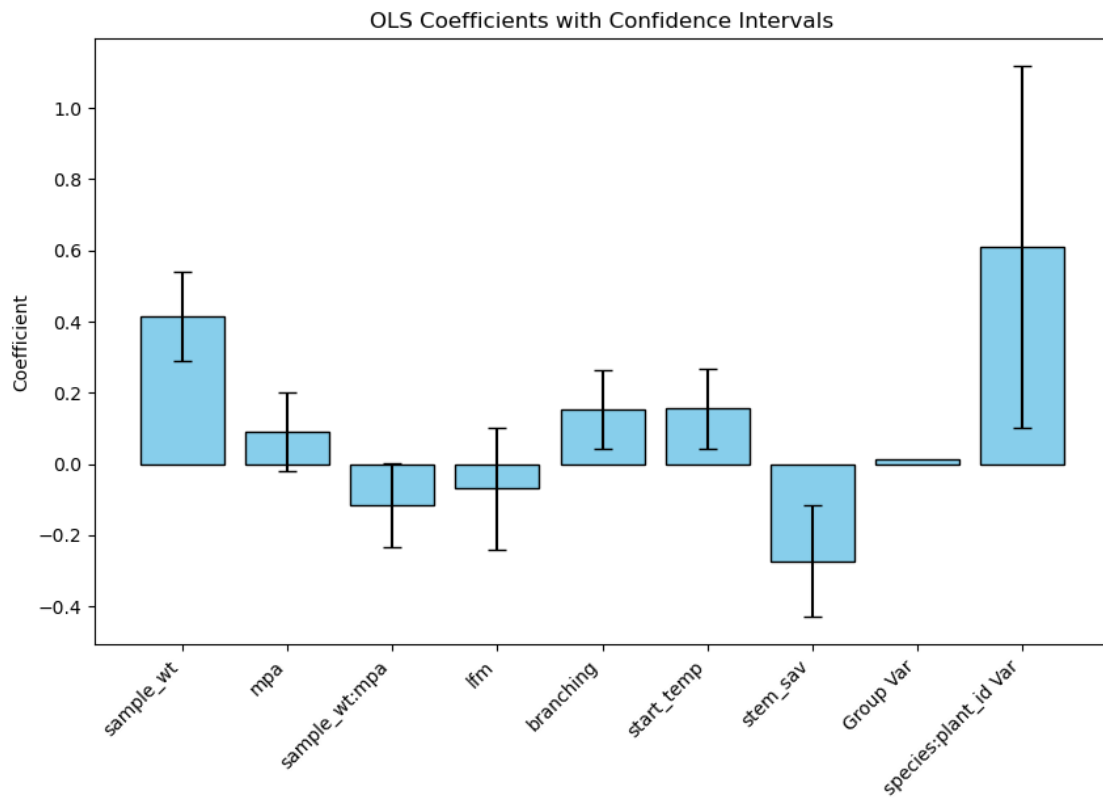


#### Mixed Linear Model Regression Results

Model:	MixedLM	Dependent Variable:	fh
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.2267
Min. group size:	2	Log-Likelihood:	-135.8773
Max. group size:	37	Converged:	Yes

Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.004	0.070	-0.053	0.958	-0.141	0.133
sample_wt	0.416	0.064	6.484	0.000	0.290	0.542
mpa	0.091	0.057	1.608	0.108	-0.020	0.202
sample_wt:mpa	-0.115	0.060	-1.936	0.053	-0.232	0.001
lfm	-0.069	0.087	-0.785	0.432	-0.240	0.103
branching	0.153	0.057	2.690	0.007	0.042	0.264
start_temp	0.156	0.058	2.709	0.007	0.043	0.269
stem_sav	-0.273	0.080	-3.413	0.001	-0.430	-0.116
Group Var	0.003					
species:plant_id Var	0.138	0.123				

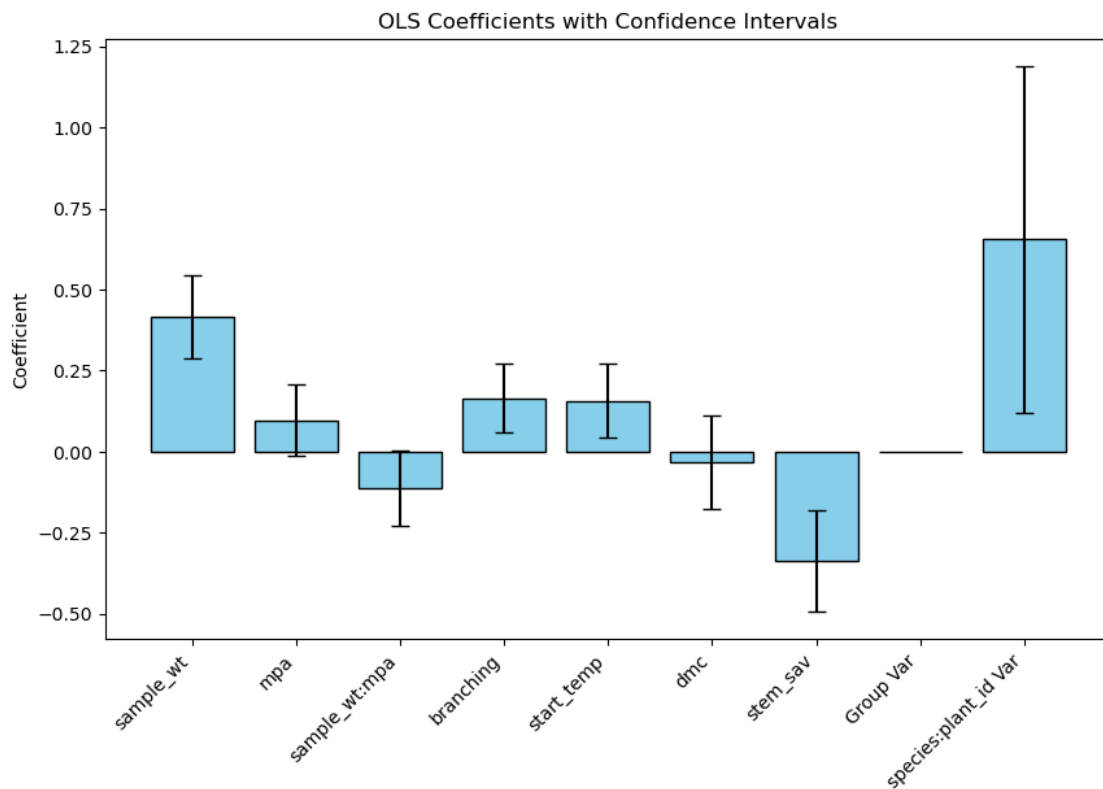


#### Mixed Linear Model Regression Results

Model:	MixedLM	Dependent Variable:	fh
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.2246

Min. group size: 2 Log-Likelihood: -135.8839  
 Max. group size: 37 Converged: Yes  
 Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.006	0.068	-0.082	0.935	-0.139	0.128
sample_wt	0.416	0.065	6.434	0.000	0.289	0.543
mpa	0.097	0.056	1.729	0.084	-0.013	0.208
sample_wt:mpa	-0.114	0.060	-1.913	0.056	-0.231	0.003
branching	0.165	0.054	3.041	0.002	0.059	0.271
start_temp	0.156	0.058	2.689	0.007	0.042	0.270
dmc	-0.033	0.074	-0.441	0.659	-0.178	0.112
stem_sav	-0.336	0.080	-4.189	0.000	-0.494	-0.179
Group Var	0.000					
species:plant_id Var	0.147	0.129				

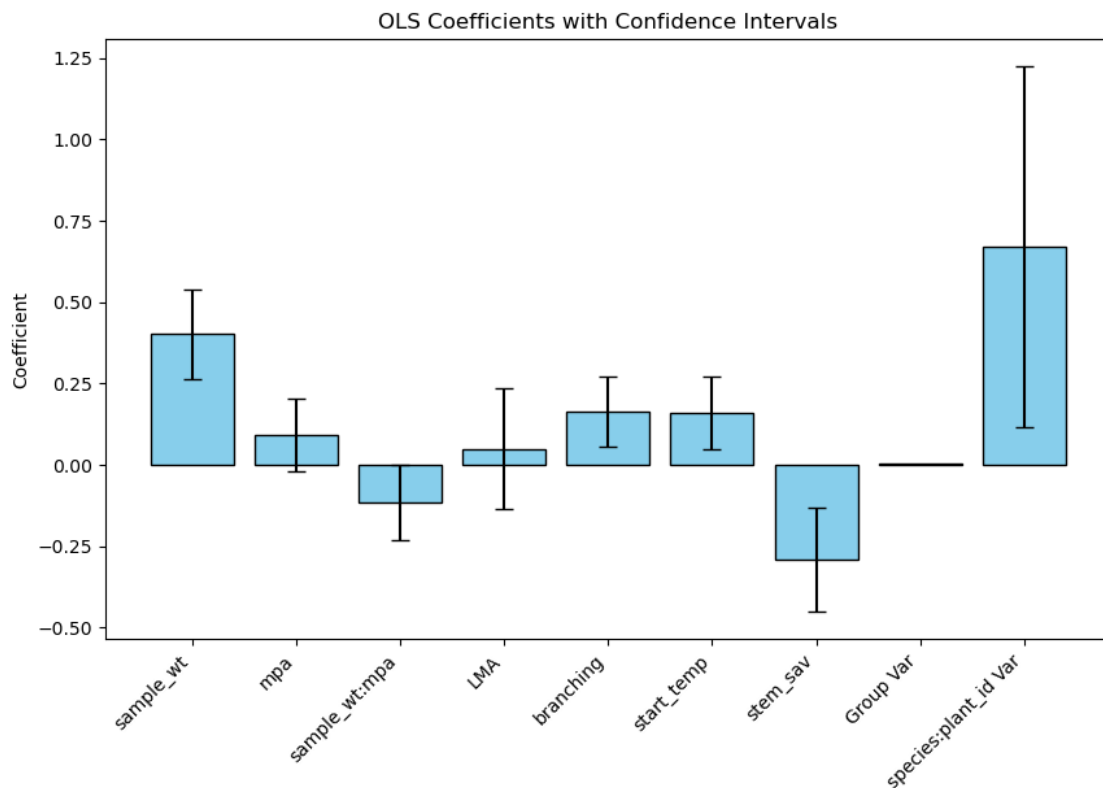


#### Mixed Linear Model Regression Results

Model: MixedLM Dependent Variable: fh

No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.2232
Min. group size:	2	Log-Likelihood:	-135.9043
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.004	0.069	-0.064	0.949	-0.141	0.132
sample_wt	0.402	0.070	5.754	0.000	0.265	0.539
mpa	0.094	0.057	1.645	0.100	-0.018	0.205
sample_wt:mpa	-0.115	0.060	-1.932	0.053	-0.232	0.002
LMA	0.050	0.094	0.527	0.598	-0.135	0.234
branching	0.163	0.054	2.999	0.003	0.056	0.270
start_temp	0.161	0.057	2.827	0.005	0.050	0.273
stem_sav	-0.292	0.081	-3.591	0.000	-0.451	-0.132
Group Var	0.001					
species:plant_id Var	0.150	0.133				



Mixed Linear Model Regression Results

```

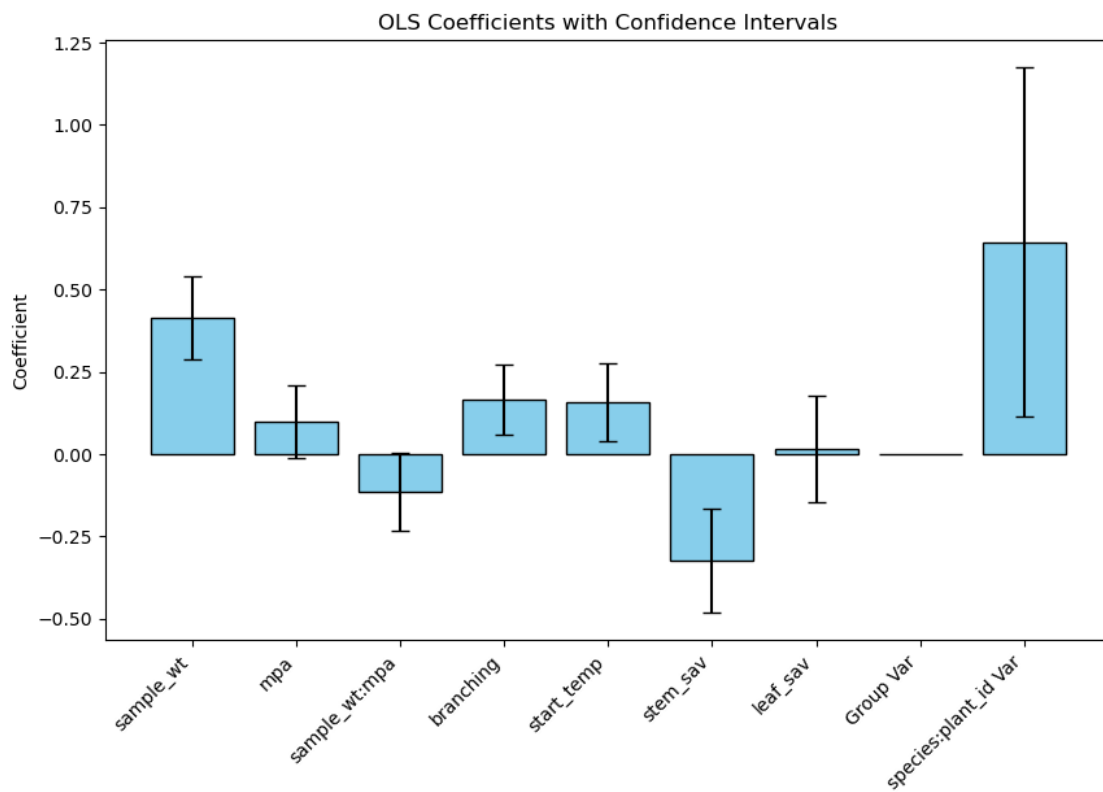
=====
Model:                MixedLM   Dependent Variable:   fh
No. Observations:     162       Method:                ML
No. Groups:            8         Scale:                0.2256
Min. group size:      2         Log-Likelihood:       -135.9620
Max. group size:      37       Converged:            Yes
Mean group size:      20.2
=====

```

```

-----
                Coef.  Std.Err.   z    P>|z|  [0.025  0.975]
-----
Intercept          -0.005    0.068  -0.077  0.939  -0.138   0.128
sample_wt           0.416    0.064   6.462  0.000   0.290   0.542
mpa                 0.097    0.056   1.727  0.084  -0.013   0.207
sample_wt:mpa      -0.115    0.060  -1.922  0.055  -0.232   0.002
branching           0.167    0.054   3.071  0.002   0.060   0.273
start_temp          0.158    0.060   2.645  0.008   0.041   0.275
stem_sav           -0.324    0.080  -4.043  0.000  -0.482  -0.167
leaf_sav            0.016    0.083   0.189  0.850  -0.147   0.178
Group Var              0.000
species:plant_id Var 0.145    0.129
=====

```



# Mixed Linear Model Regression Results

```

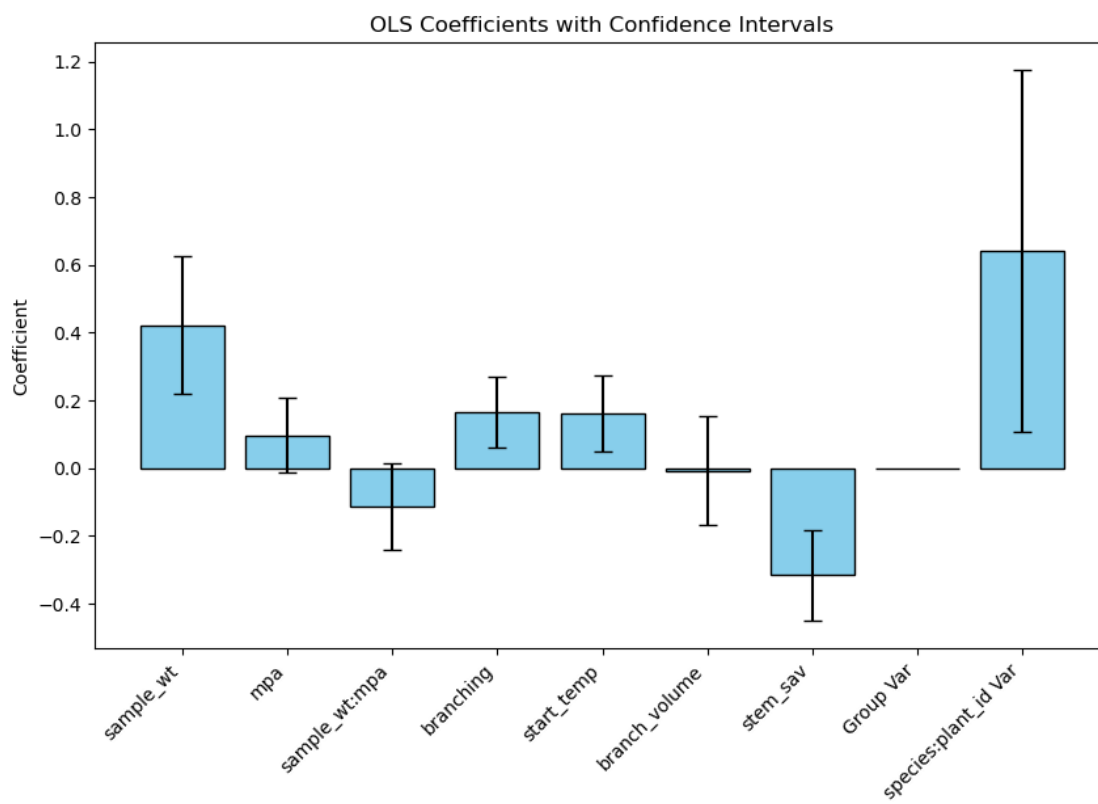
=====
Model:                MixedLM   Dependent Variable:   fh
No. Observations:    162       Method:              ML
No. Groups:          8         Scale:              0.2257
Min. group size:     2         Log-Likelihood:    -135.9760
Max. group size:     37       Converged:         Yes
Mean group size:     20.2
=====

```

```

-----
              Coef.  Std.Err.   z    P>|z|  [0.025  0.975]
-----
Intercept          -0.004    0.068  -0.057  0.954  -0.137   0.129
sample_wt           0.422    0.103   4.096  0.000   0.220   0.624
mpa                 0.098    0.057   1.728  0.084  -0.013   0.209
sample_wt:mpa       -0.112    0.065  -1.722  0.085  -0.239   0.015
branching           0.166    0.054   3.062  0.002   0.060   0.272
start_temp          0.162    0.057   2.829  0.005   0.050   0.274
branch_volume       -0.007    0.081  -0.087  0.930  -0.167   0.153
stem_sav            -0.316    0.069  -4.615  0.000  -0.450  -0.182
Group Var           0.000
species:plant_id Var 0.145    0.129
=====

```



## 5 Flame Duration

```
[9]: yvar='fd'
     cols=cols_use
     df=flam
     compare_predictors_mixedeff(df, cols, yvar)
```

	cols	aics	pvals	coefs	top_mod
0	mpa	446.750330	-0.045917	6.229635e-01	True
1	start_temp	446.445675	-0.046927	5.914359e-01	True
2	thickness	445.980840	0.065724	4.658912e-01	True
3	branching	445.895056	0.145043	1.196389e-01	True
4	leaf_sav	445.496714	-0.092000	3.336763e-01	True
5	LMA	444.851697	0.305154	1.408714e-02	True
6	lfm	444.134673	-0.255362	5.476824e-02	False
7	leaf_mass_ratio	443.949117	-0.241753	2.874643e-02	False
8	stem_sav	442.180284	-0.349600	9.230438e-03	False
9	branch_volume	435.619538	0.317514	4.464033e-04	False
10	dmc	435.194484	0.409251	2.901647e-04	False
11	sample_wt	420.165104	0.484080	4.249122e-08	False

```
[10]: AIC_iterator(flam, cols_use, Y_VAR='fd',
                  minnumsingle=mns, maxnumsingle=mxs, minnumint=mni, maxnumint=mxl)
```

ERROR: Formula model error: fd ~ leaf\_sav\*thickness

Columns present in sig. interaction terms: {'dmc', 'sample\_wt'}

Total Num. Cols : Num. Sig. Int. Cols; 12 : 2

Significant Interactions:  
('sample\_wt', 'dmc')

Number of formulas: 1024

```
fd ~ sample_wt*dmc + leaf_mass_ratio
fd ~ sample_wt*dmc
fd ~ sample_wt*dmc + branching
fd ~ sample_wt*dmc + leaf_mass_ratio + mpa
fd ~ sample_wt*dmc + leaf_mass_ratio + stem_sav
fd ~ sample_wt*dmc + lfm
fd ~ sample_wt*dmc + lfm + leaf_mass_ratio
fd ~ sample_wt*dmc + leaf_mass_ratio + branching
```



# Mixed Linear Model Regression Results

```

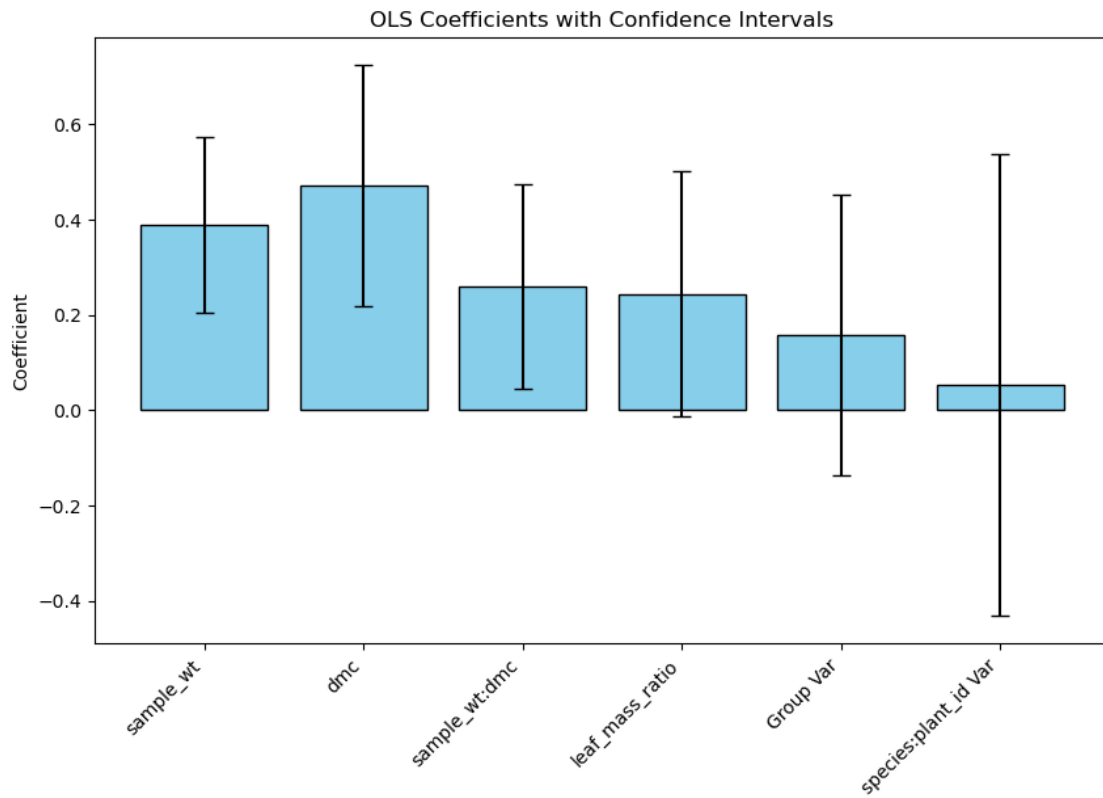
=====
Model:                MixedLM   Dependent Variable:   fd
No. Observations:    162       Method:              ML
No. Groups:          8         Scale:             0.5873
Min. group size:     2         Log-Likelihood:    -195.4017
Max. group size:     37       Converged:         Yes
Mean group size:     20.2
=====

```

```

-----
                Coef.  Std.Err.   z    P>|z|  [0.025  0.975]
-----
Intercept          -0.088    0.142  -0.621  0.535  -0.366   0.190
sample_wt           0.389    0.094   4.125  0.000   0.204   0.573
dmc                 0.471    0.129   3.637  0.000   0.217   0.724
sample_wt:dmc       0.259    0.109   2.371  0.018   0.045   0.474
leaf_mass_ratio     0.244    0.131   1.865  0.062  -0.012   0.501
Group Var           0.093    0.115
species:plant_id Var 0.031    0.189
=====

```



# Mixed Linear Model Regression Results

```

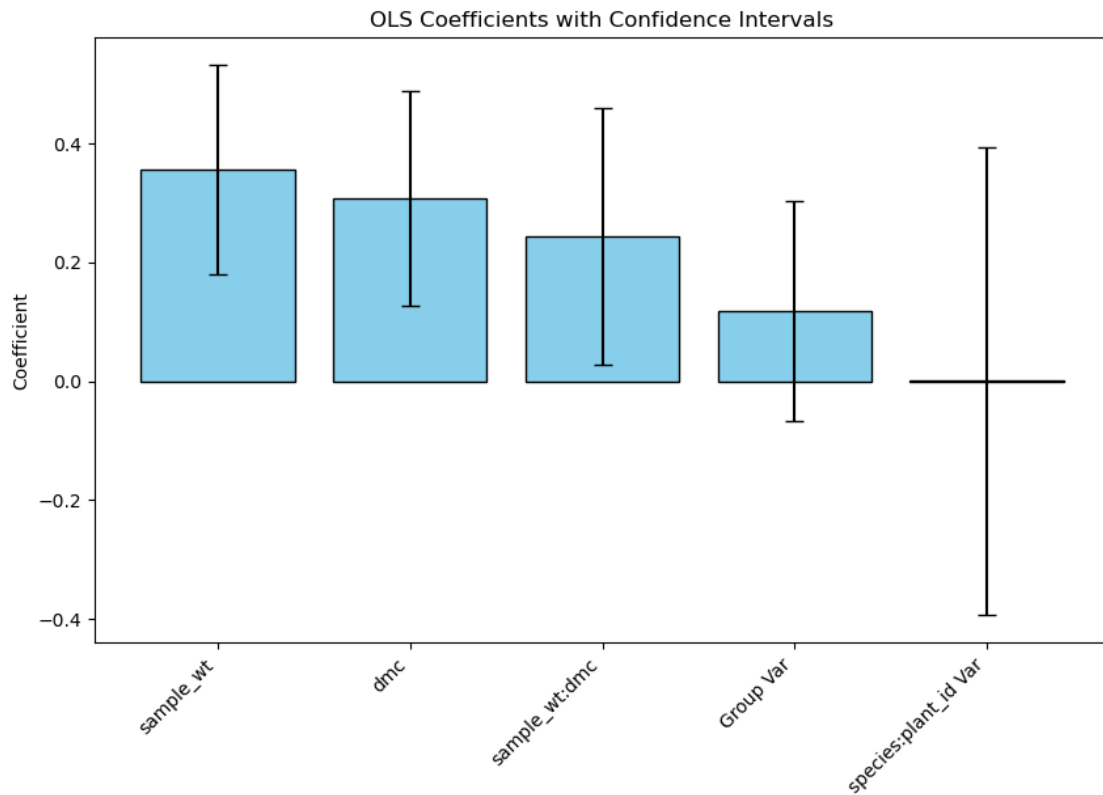
=====
Model:                MixedLM   Dependent Variable:   fd
No. Observations:     162       Method:              ML
No. Groups:            8        Scale:              0.6285
Min. group size:      2        Log-Likelihood:    -196.7721
Max. group size:      37       Converged:         No
Mean group size:      20.2
=====

```

```

-----
              Coef.  Std.Err.   z    P>|z|  [0.025  0.975]
-----
Intercept          -0.086    0.130  -0.659  0.510  -0.342   0.170
sample_wt           0.356    0.090   3.963  0.000   0.180   0.531
dmc                 0.308    0.092   3.345  0.001   0.127   0.488
sample_wt:dmc       0.244    0.110   2.218  0.027   0.028   0.460
Group Var           0.074    0.075
species:plant_id Var 0.000    0.159
=====

```



# Mixed Linear Model Regression Results

```

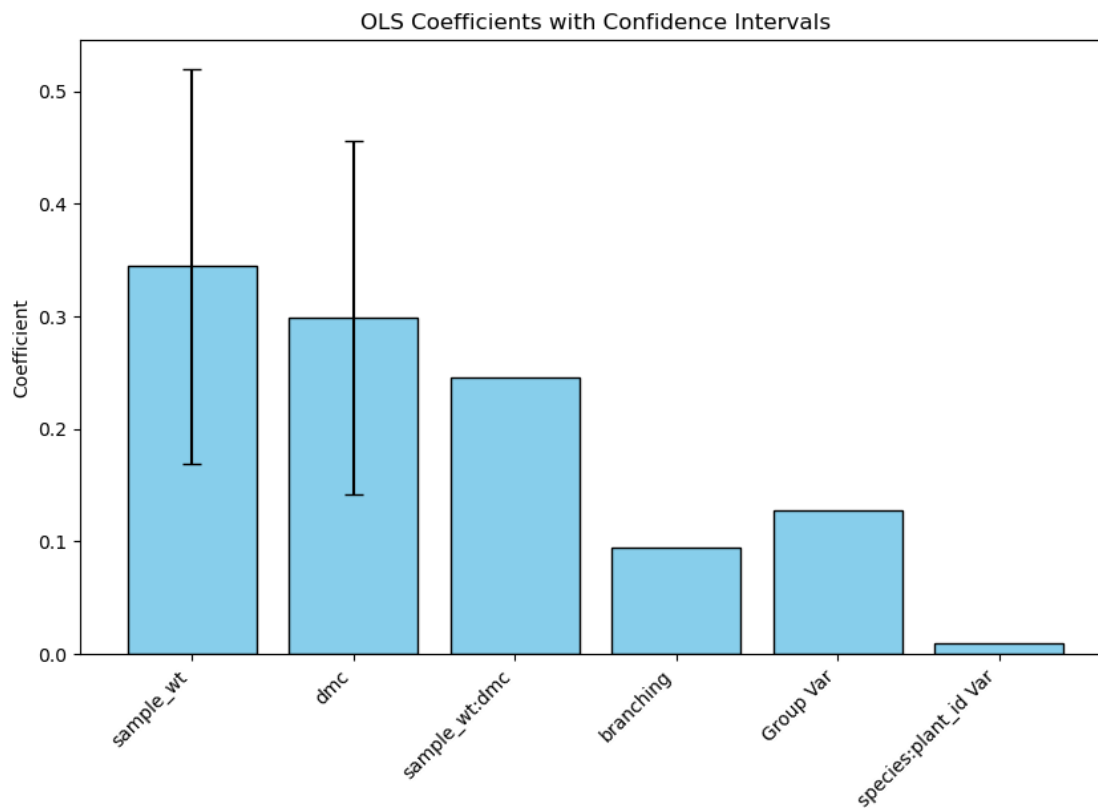
Model:                MixedLM   Dependent Variable:   fd
No. Observations:    162       Method:              ML
No. Groups:          8         Scale:             0.6165
Min. group size:     2         Log-Likelihood:    -196.0384
Max. group size:     37       Converged:         Yes
Mean group size:     20.2

```

```

-----
                Coef.  Std.Err.   z    P>|z| [0.025  0.975]
-----
Intercept                -0.091
sample_wt                 0.344    0.089  3.859  0.000   0.170   0.519
dmc                      0.298    0.080  3.731  0.000   0.142   0.455
sample_wt:dmc             0.246
branching                 0.095
Group Var                 0.079
species:plant_id Var      0.006
=====

```



#### Mixed Linear Model Regression Results

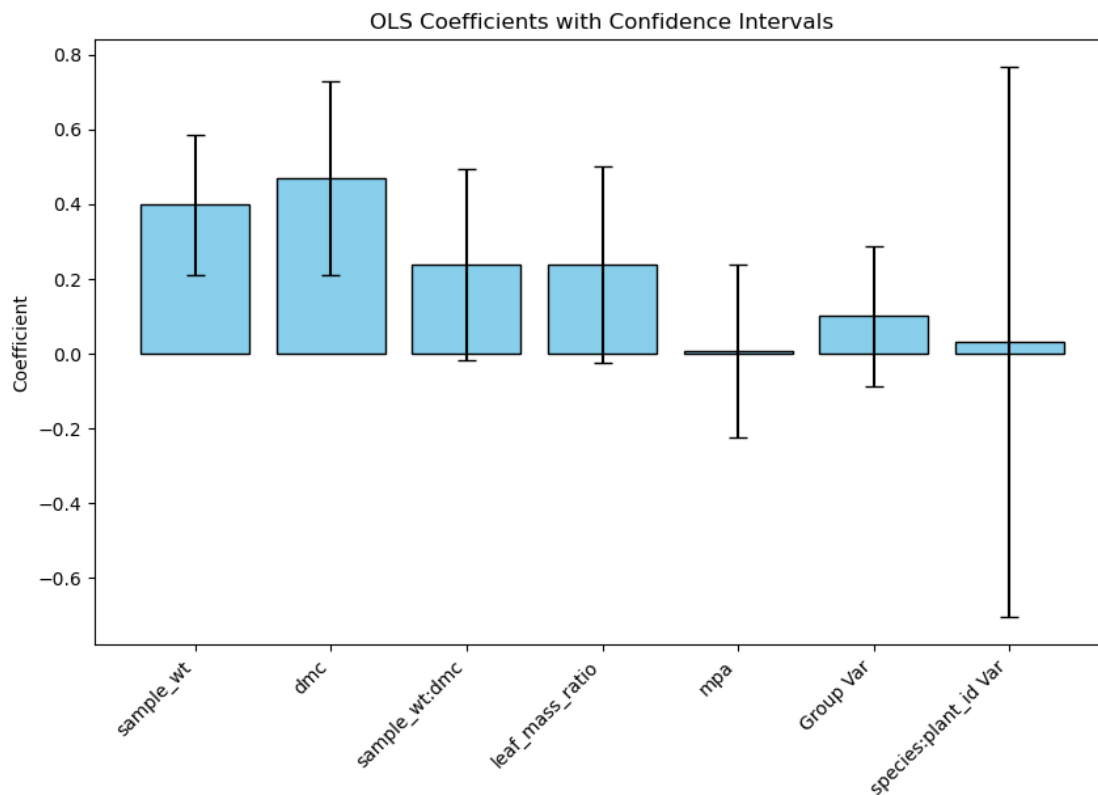
```

=====
Model:                MixedLM   Dependent Variable:   fd

```

No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.6035
Min. group size:	2	Log-Likelihood:	-195.1395
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.077	0.138	-0.555	0.579	-0.347	0.194
sample_wt	0.398	0.095	4.189	0.000	0.212	0.584
dmc	0.469	0.132	3.550	0.000	0.210	0.728
sample_wt:dmc	0.239	0.131	1.826	0.068	-0.018	0.495
leaf_mass_ratio	0.238	0.133	1.786	0.074	-0.023	0.499
mpa	0.007	0.118	0.057	0.955	-0.224	0.238
Group Var	0.061	0.074				
species:plant_id Var	0.019	0.292				

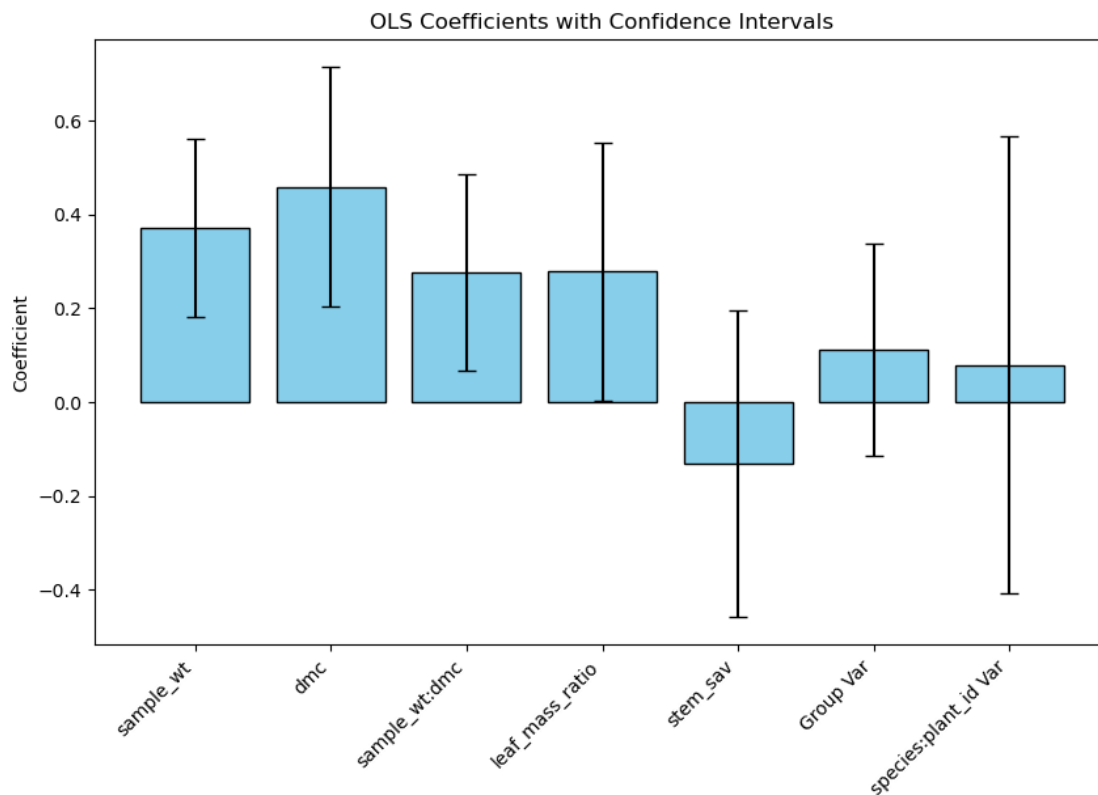


#### Mixed Linear Model Regression Results

Model: MixedLM Dependent Variable: fd

No. Observations: 162      Method: ML  
 No. Groups: 8      Scale: 0.5812  
 Min. group size: 2      Log-Likelihood: -195.1888  
 Max. group size: 37      Converged: No  
 Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.107	0.130	-0.819	0.413	-0.362	0.148
sample_wt	0.371	0.096	3.848	0.000	0.182	0.559
dmc	0.458	0.130	3.519	0.000	0.203	0.713
sample_wt:dmc	0.276	0.107	2.584	0.010	0.067	0.485
leaf_mass_ratio	0.278	0.140	1.985	0.047	0.003	0.553
stem_sav	-0.131	0.167	-0.785	0.432	-0.458	0.196
Group Var	0.065	0.087				
species:plant_id Var	0.046	0.190				

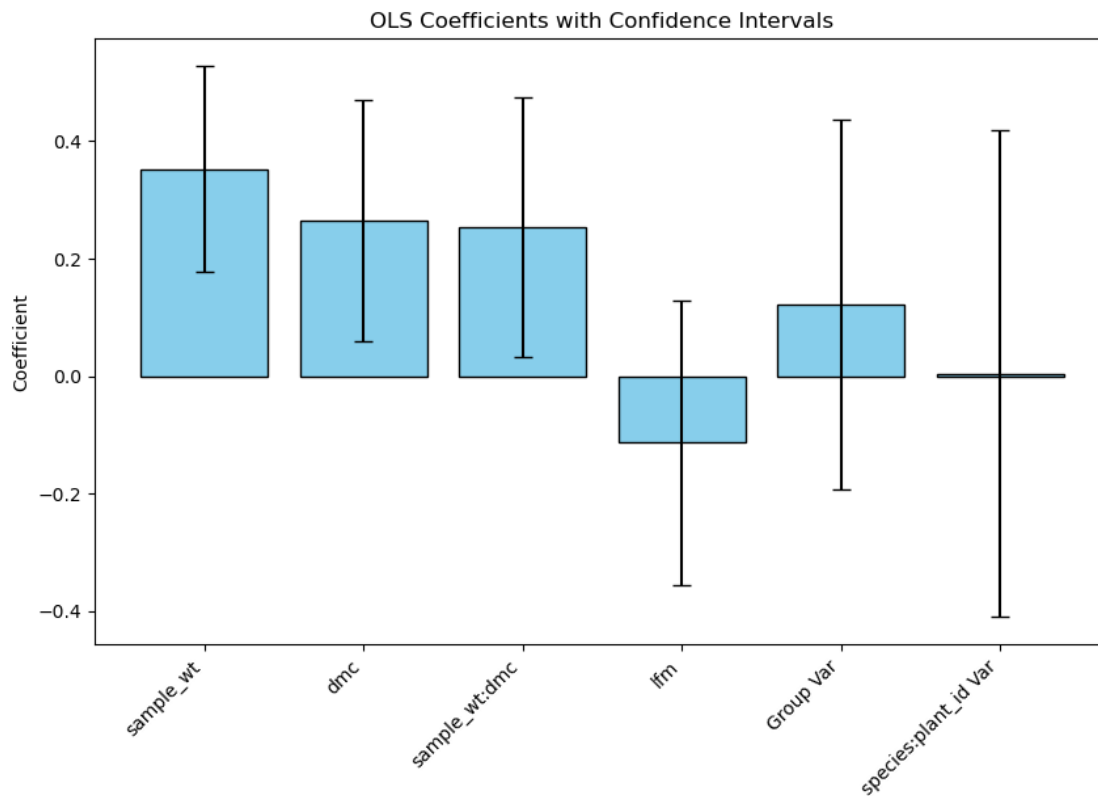


#### Mixed Linear Model Regression Results

Model: MixedLM      Dependent Variable: fd

No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.6218
Min. group size:	2	Log-Likelihood:	-196.2606
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.097	0.133	-0.727	0.467	-0.358	0.164
sample_wt	0.352	0.089	3.942	0.000	0.177	0.528
dmc	0.265	0.105	2.538	0.011	0.060	0.470
sample_wt:dmc	0.254	0.113	2.252	0.024	0.033	0.476
lfm	-0.113	0.124	-0.915	0.360	-0.356	0.130
Group Var	0.075	0.127				
species:plant_id Var	0.003	0.167				

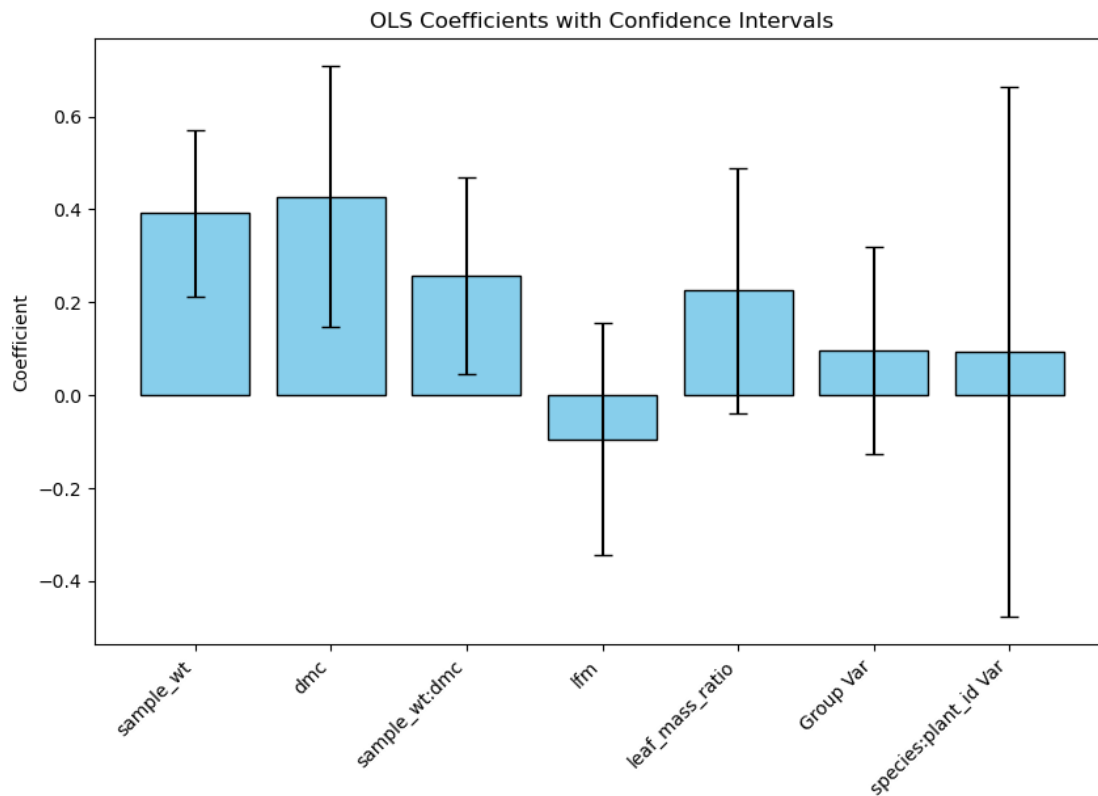


#### Mixed Linear Model Regression Results

Model:	MixedLM	Dependent Variable:	fd
No. Observations:	162	Method:	ML

No. Groups:	8	Scale:	0.5789
Min. group size:	2	Log-Likelihood:	-195.3070
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.094	0.125	-0.747	0.455	-0.339	0.152
sample_wt	0.392	0.092	4.277	0.000	0.212	0.572
dmc	0.428	0.143	2.985	0.003	0.147	0.709
sample_wt:dmc	0.257	0.108	2.369	0.018	0.044	0.469
lfm	-0.095	0.128	-0.745	0.456	-0.346	0.155
leaf_mass_ratio	0.225	0.134	1.678	0.093	-0.038	0.488
Group Var	0.056	0.086				
species:plant_id Var	0.054	0.221				

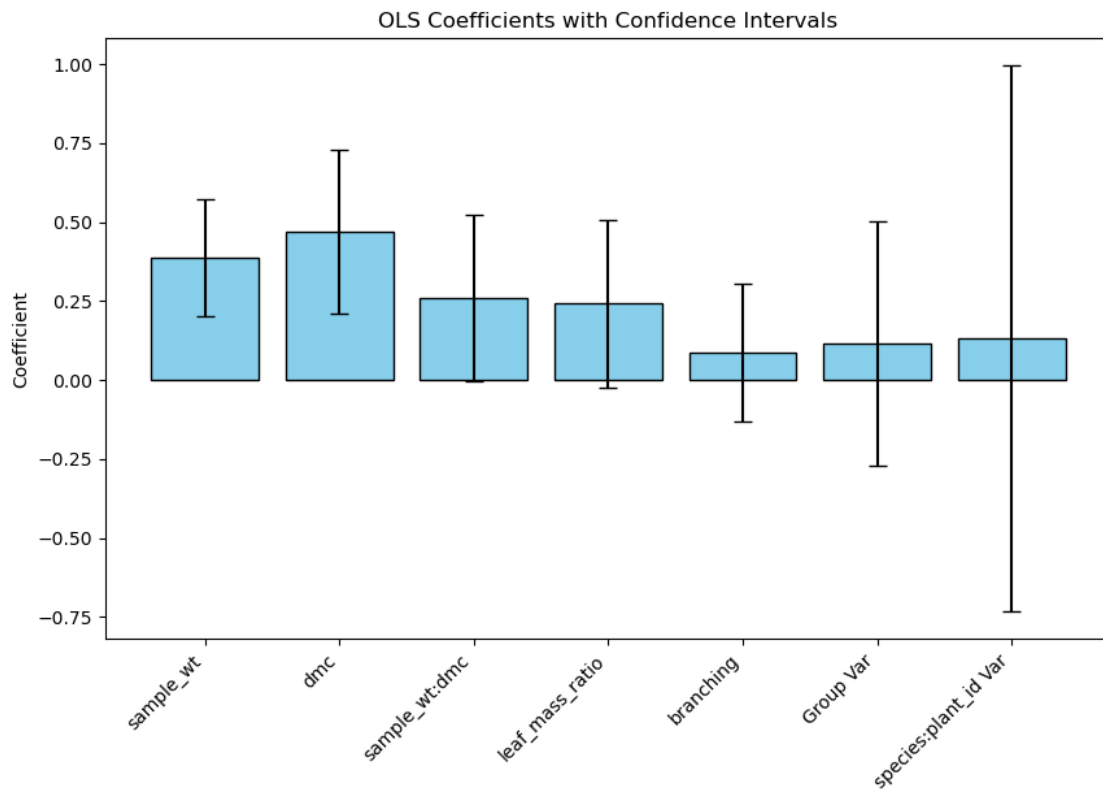


#### Mixed Linear Model Regression Results

Model:	MixedLM	Dependent Variable:	fd
No. Observations:	162	Method:	ML

No. Groups:	8	Scale:	0.5629
Min. group size:	2	Log-Likelihood:	-195.3271
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.093	0.138	-0.670	0.503	-0.363	0.178
sample_wt	0.387	0.094	4.119	0.000	0.203	0.571
dmc	0.470	0.133	3.535	0.000	0.209	0.730
sample_wt:dmc	0.258	0.134	1.920	0.055	-0.005	0.522
leaf_mass_ratio	0.241	0.136	1.767	0.077	-0.026	0.508
branching	0.088	0.111	0.790	0.430	-0.130	0.305
Group Var	0.065	0.148				
species:plant_id Var	0.074	0.331				





## 6 Temp Change

```
[11]: yvar='temp_change'
      cols=cols_use
      df=flam
      compare_predictors_mixedeff(df, cols, yvar)
```

	cols	aics	pvals	coefs	top_mod
0	LMA	304.534939	0.097680	4.176065e-01	True
1	dmc	303.949995	0.089897	2.708376e-01	True
2	branch_volume	303.464900	0.077979	1.971672e-01	True
3	leaf_mass_ratio	302.284645	-0.167626	7.418627e-02	False
4	thickness	302.081699	0.138460	7.364841e-02	False
5	leaf_sav	302.043892	-0.150075	7.109881e-02	False
6	lfm	301.232764	-0.197459	4.315243e-02	False
7	stem_sav	300.585701	-0.254306	2.181084e-03	False
8	mpa	300.174135	0.140693	2.528577e-02	False
9	sample_wt	296.458956	0.210282	3.440285e-03	False
10	branching	296.043031	0.171873	2.301602e-03	False
11	start_temp	272.278944	-0.350094	5.298375e-10	False

```
[12]: AIC_iterator(flam, cols_use, Y_VAR='temp_change',
                  minnumsingle=mns, maxnumsingle=mxs, minnumint=mni, maxnumint=mxi)
```

ERROR: Formula model error: temp\_change ~ leaf\_sav\*thickness

Columns present in sig. interaction terms: {'start\_temp', 'sample\_wt'}

Total Num. Cols : Num. Sig. Int. Cols; 12 : 2

Significant Interactions:  
('sample\_wt', 'start\_temp')

Number of formulas: 1024

ERROR: Formula model error: temp\_change ~ sample\_wt\*start\_temp + leaf\_mass\_ratio + branching + stem\_sav + leaf\_sav + thickness

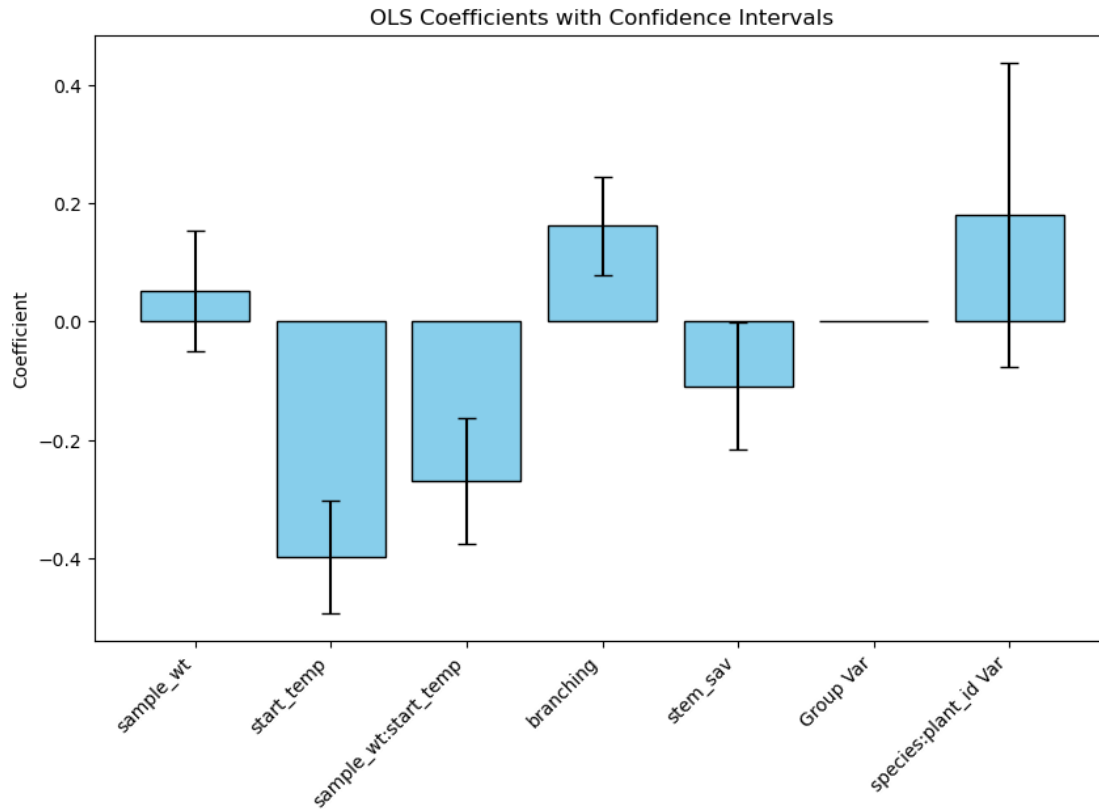
```
temp_change ~ sample_wt*start_temp + branching + stem_sav
temp_change ~ sample_wt*start_temp + branching + branch_volume + stem_sav
temp_change ~ sample_wt*start_temp + branching + mpa + stem_sav
temp_change ~ sample_wt*start_temp + lfm + branching + mpa
temp_change ~ sample_wt*start_temp + lfm + leaf_mass_ratio + branching
temp_change ~ sample_wt*start_temp + LMA + branching + stem_sav
temp_change ~ sample_wt*start_temp + LMA + branching + branch_volume + stem_sav
temp_change ~ sample_wt*start_temp + lfm + branching
temp_change ~ sample_wt*start_temp + branching + stem_sav + thickness
temp_change ~ sample_wt*start_temp + lfm + branching + dmc
```

```
temp_change ~ sample_wt*start_temp + branching + mpa + branch_volume + stem_sav
temp_change ~ sample_wt*start_temp + branching
temp_change ~ sample_wt*start_temp + leaf_mass_ratio + branching
```

#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM   Dependent Variable:  temp_change
No. Observations:    162       Method:                ML
No. Groups:          8         Scale:              0.1971
Min. group size:     2         Log-Likelihood:     -109.3537
Max. group size:     37       Converged:          Yes
Mean group size:     20.2
=====
```

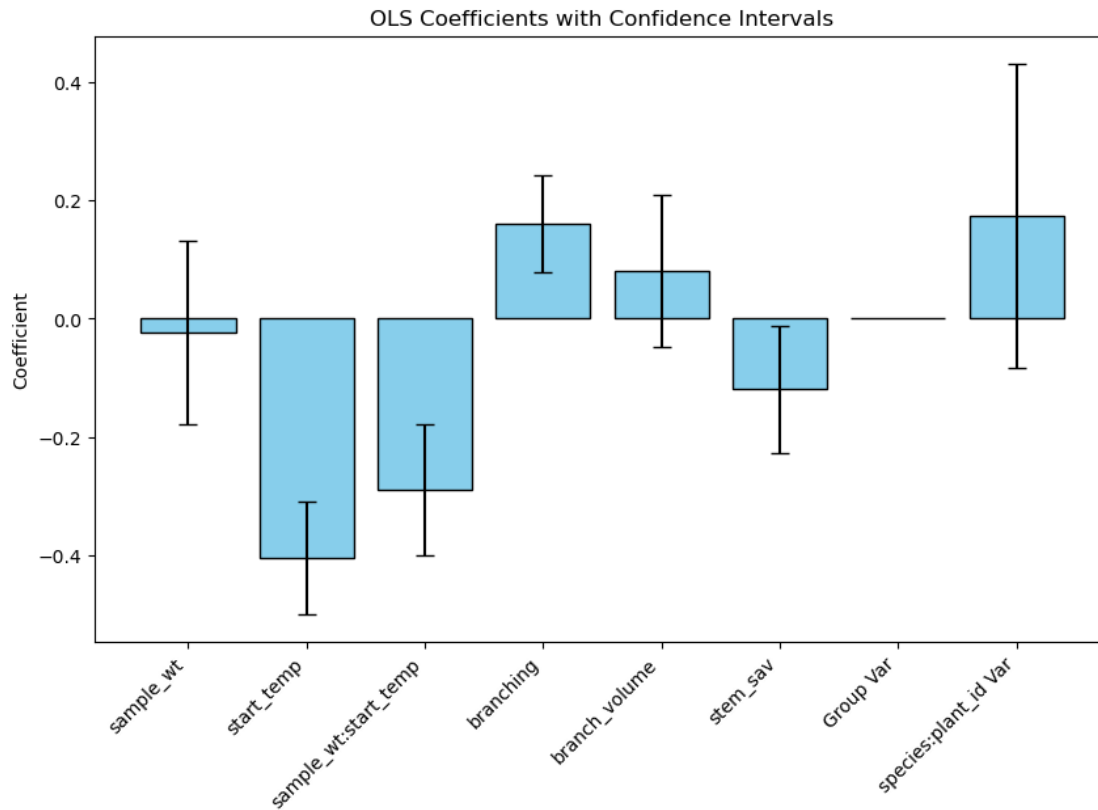
```
-----
              Coef.  Std.Err.   z    P>|z| [0.025 0.975]
-----
Intercept          -0.101    0.048 -2.127 0.033 -0.194 -0.008
sample_wt           0.051    0.052  0.975 0.330 -0.051  0.152
start_temp        -0.398    0.048 -8.212 0.000 -0.492 -0.303
sample_wt:start_temp -0.269    0.054 -4.937 0.000 -0.376 -0.162
branching           0.161    0.042  3.841 0.000  0.079  0.244
stem_sav          -0.109    0.055 -1.991 0.046 -0.217 -0.002
Group Var           0.000
species:plant_id Var 0.036    0.058
=====
```



#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM   Dependent Variable:  temp_change
No. Observations:    162       Method:              ML
No. Groups:          8         Scale:               0.1960
Min. group size:     2         Log-Likelihood:      -108.5869
Max. group size:     37        Converged:           No
Mean group size:     20.2
=====
```

```
-----
              Coef.  Std.Err.   z    P>|z| [0.025 0.975]
-----
Intercept          -0.106    0.047 -2.249 0.025 -0.198 -0.014
sample_wt           -0.024    0.079 -0.302 0.763 -0.179  0.131
start_temp          -0.404    0.049 -8.338 0.000 -0.500 -0.309
sample_wt:start_temp -0.289    0.057 -5.117 0.000 -0.400 -0.179
branching            0.160    0.042  3.834 0.000  0.078  0.242
branch_volume        0.081    0.066  1.242 0.214 -0.047  0.210
stem_sav            -0.119    0.055 -2.179 0.029 -0.227 -0.012
Group Var            0.000
species:plant_id Var 0.034    0.058
=====
```

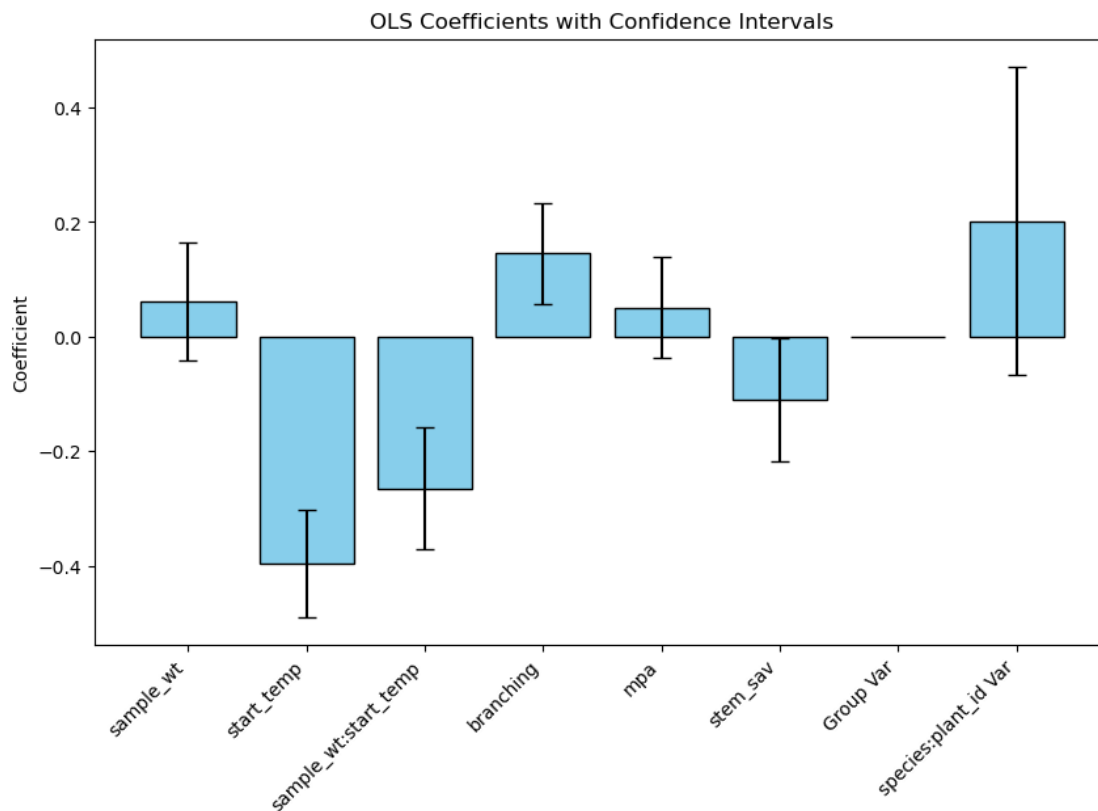


#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM   Dependent Variable:  temp_change
No. Observations:    162       Method:                ML
No. Groups:           8        Scale:                0.1932
Min. group size:      2        Log-Likelihood:       -108.7121
Max. group size:      37       Converged:            No
Mean group size:      20.2
=====
```

```
-----
              Coef.  Std.Err.   z    P>|z| [0.025 0.975]
-----
Intercept      -0.098    0.048 -2.040 0.041 -0.193 -0.004
sample_wt       0.062    0.053  1.173 0.241 -0.042  0.165
start_temp     -0.396    0.048 -8.265 0.000 -0.489 -0.302
sample_wt:start_temp -0.265    0.054 -4.877 0.000 -0.372 -0.159
branching       0.145    0.044  3.264 0.001  0.058  0.232
mpa             0.051    0.045  1.123 0.261 -0.038  0.139
stem_sav       -0.110    0.055 -1.994 0.046 -0.219 -0.002
Group Var       0.000
species:plant_id Var 0.039    0.060
-----
```

=====



#### Mixed Linear Model Regression Results

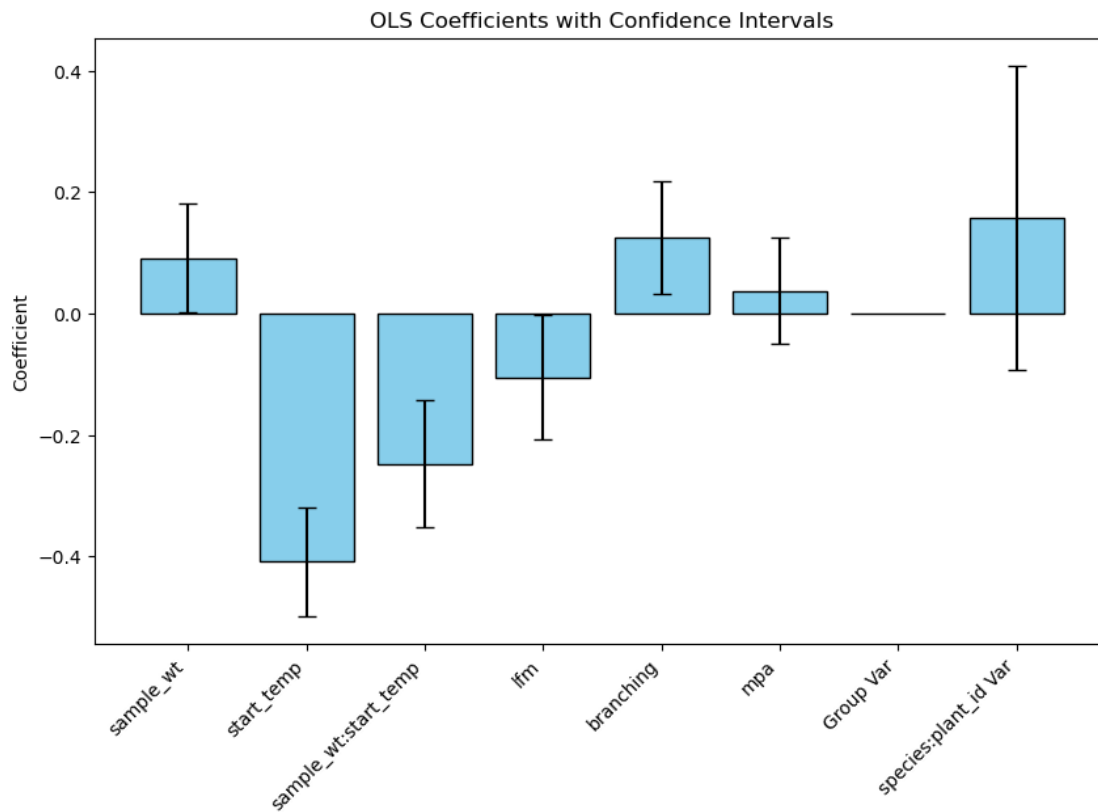
=====

Model:	MixedLM	Dependent Variable:	temp_change
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.1985
Min. group size:	2	Log-Likelihood:	-108.8481
Max. group size:	37	Converged:	No
Mean group size:	20.2		

-----

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.090	0.047	-1.929	0.054	-0.182	0.001
sample_wt	0.092	0.046	1.985	0.047	0.001	0.182
start_temp	-0.409	0.046	-8.958	0.000	-0.499	-0.320
sample_wt:start_temp	-0.248	0.054	-4.637	0.000	-0.353	-0.143
lfm	-0.105	0.052	-2.012	0.044	-0.208	-0.003
branching	0.126	0.047	2.660	0.008	0.033	0.219
mpa	0.037	0.045	0.826	0.409	-0.051	0.125
Group Var	0.000					

species:plant\_id Var 0.031 0.057



#### Mixed Linear Model Regression Results

```

=====
Model:                MixedLM    Dependent Variable:  temp_change
No. Observations:    162        Method:                ML
No. Groups:           8         Scale:                0.2014
Min. group size:     2         Log-Likelihood:      -108.8672
Max. group size:     37        Converged:           Yes
Mean group size:     20.2
  
```

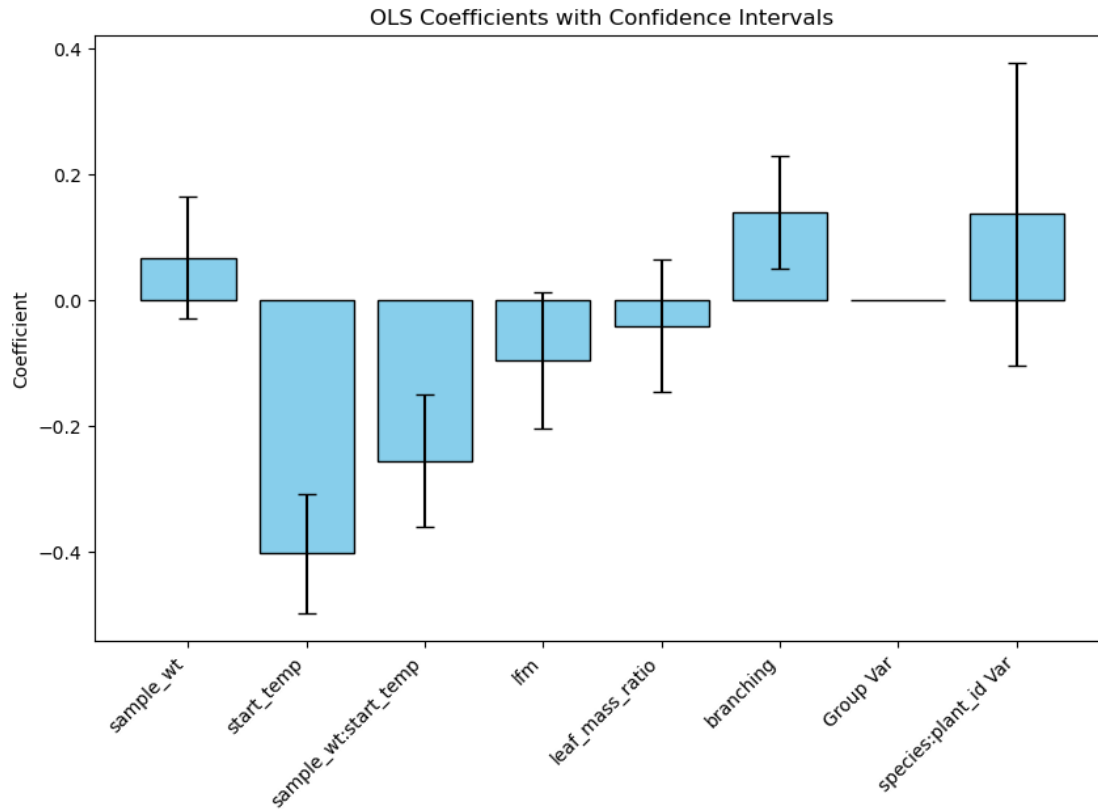
```

-----
                Coef.  Std.Err.   z    P>|z|  [0.025  0.975]
-----
Intercept        -0.095    0.046  -2.082  0.037  -0.185  -0.006
sample_wt         0.067    0.050   1.360  0.174  -0.030   0.164
start_temp       -0.402    0.048  -8.330  0.000  -0.497  -0.307
sample_wt:start_temp -0.255    0.054  -4.762  0.000  -0.360  -0.150
lfm              -0.096    0.055  -1.737  0.082  -0.205   0.012
leaf_mass_ratio  -0.041    0.053  -0.767  0.443  -0.145   0.064
branching         0.139    0.046   3.028  0.002   0.049   0.229
  
```

```

Group Var          0.000
species:plant_id Var 0.027    0.055
=====

```



#### Mixed Linear Model Regression Results

```

=====
Model:           MixedLM   Dependent Variable:  temp_change
No. Observations: 162      Method:             ML
No. Groups:       8        Scale:             0.1983
Min. group size:  2        Log-Likelihood:   -108.8724
Max. group size:  37       Converged:          Yes
Mean group size:  20.2
=====

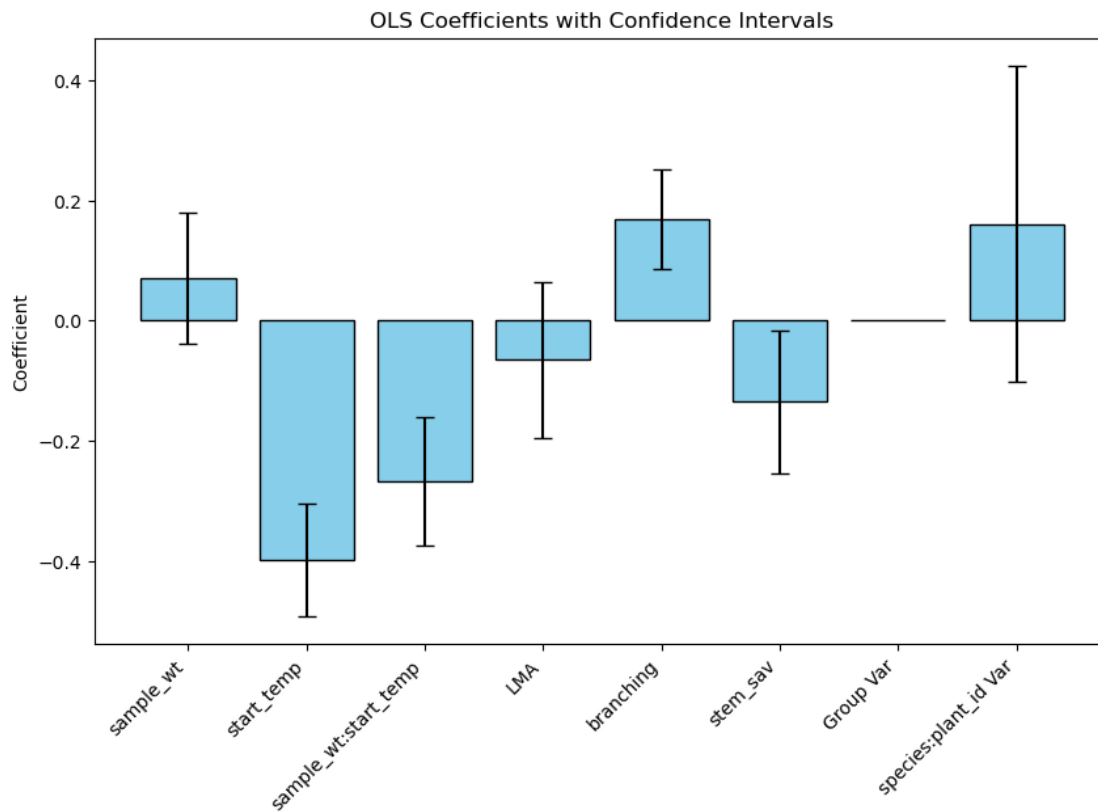
```

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.103	0.047	-2.201	0.028	-0.195	-0.011
sample_wt	0.071	0.055	1.276	0.202	-0.038	0.179
start_temp	-0.398	0.048	-8.310	0.000	-0.492	-0.304
sample_wt:start_temp	-0.268	0.054	-4.920	0.000	-0.374	-0.161
LMA	-0.066	0.066	-0.998	0.318	-0.195	0.063
branching	0.168	0.042	3.964	0.000	0.085	0.252

```

stem_sav          -0.135    0.060 -2.243 0.025 -0.254 -0.017
Group Var          0.000
species:plant_id Var 0.032    0.060
=====

```



#### Mixed Linear Model Regression Results

```

=====
Model:                MixedLM   Dependent Variable:  temp_change
No. Observations:    162        Method:                ML
No. Groups:           8         Scale:                0.1989
Min. group size:      2         Log-Likelihood:       -107.8804
Max. group size:      37        Converged:            Yes
Mean group size:      20.2
=====

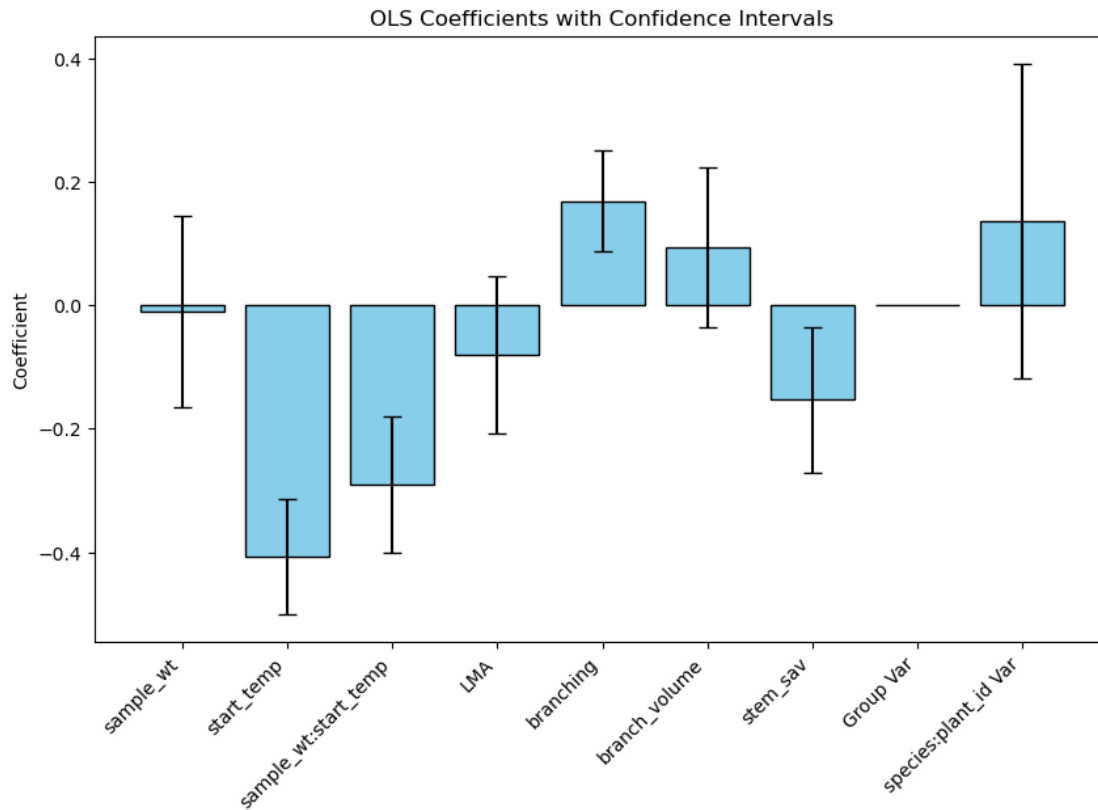
```

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.109	0.046	-2.388	0.017	-0.199	-0.020
sample_wt	-0.011	0.079	-0.137	0.891	-0.166	0.145
start_temp	-0.407	0.048	-8.559	0.000	-0.500	-0.314
sample_wt:start_temp	-0.291	0.056	-5.178	0.000	-0.401	-0.181
LMA	-0.081	0.065	-1.246	0.213	-0.207	0.046



branching	0.169	0.042	4.020	0.000	0.087	0.251
branch_volume	0.094	0.066	1.422	0.155	-0.035	0.223
stem_sav	-0.153	0.060	-2.541	0.011	-0.271	-0.035
Group Var	0.000					
species:plant_id Var	0.027	0.058				

=====



#### Mixed Linear Model Regression Results

=====

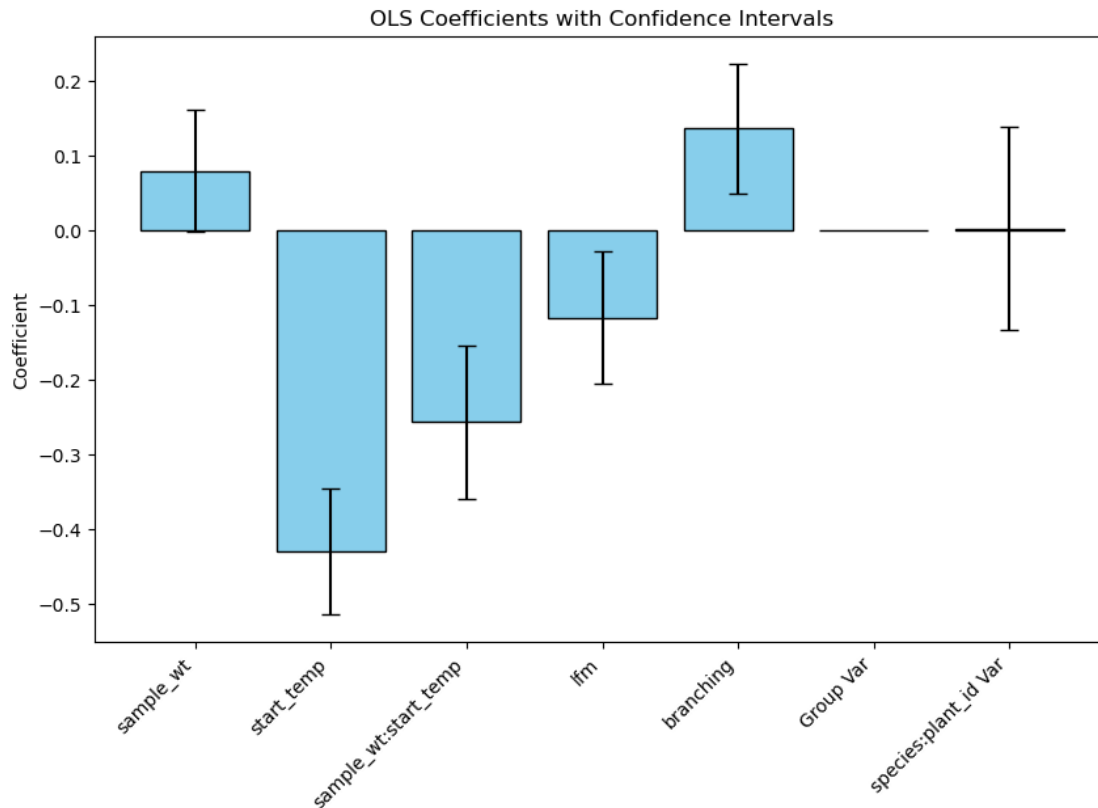
Model:	MixedLM	Dependent Variable:	temp_change
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.2270
Min. group size:	2	Log-Likelihood:	-109.8950
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

-----

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.102	0.040	-2.550	0.011	-0.180	-0.024
sample_wt	0.079	0.042	1.899	0.058	-0.003	0.161
start_temp	-0.430	0.043	-10.046	0.000	-0.514	-0.346

sample_wt:start_temp	-0.257	0.052	-4.913	0.000	-0.360	-0.155
lfm	-0.117	0.045	-2.585	0.010	-0.206	-0.028
branching	0.136	0.044	3.070	0.002	0.049	0.223
Group Var	0.000					
species:plant_id Var	0.000	0.033				

=====



#### Mixed Linear Model Regression Results

=====

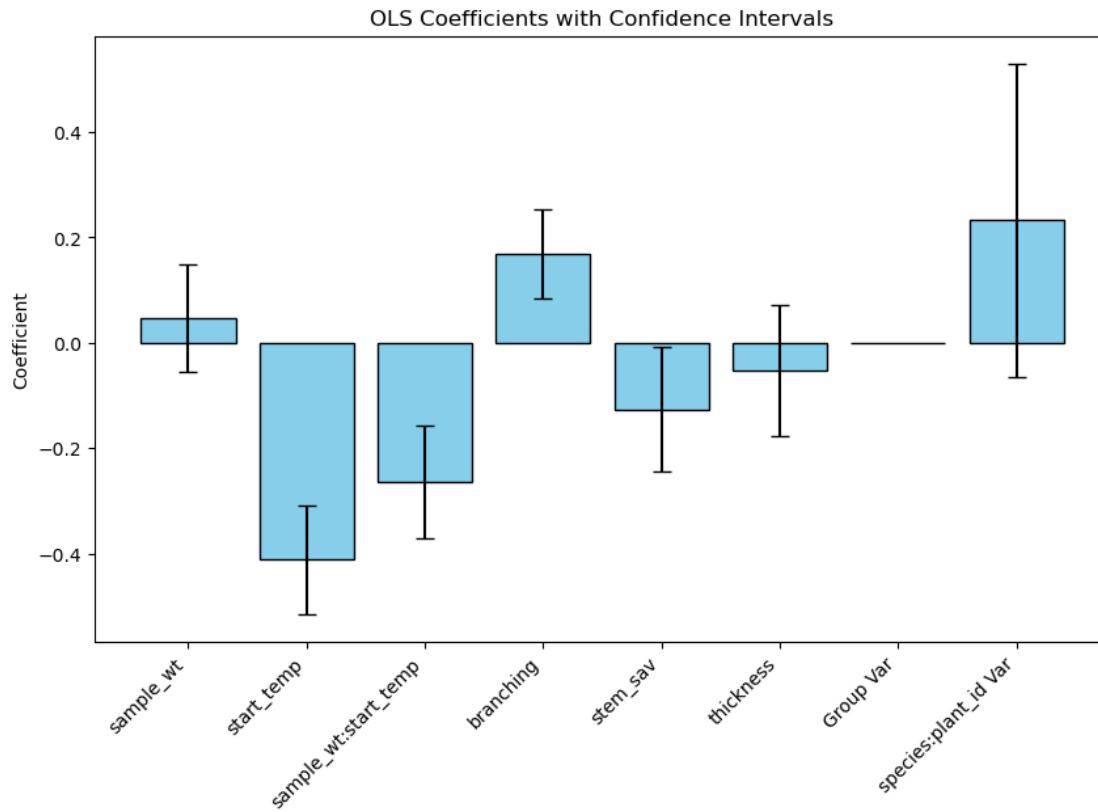
Model:	MixedLM	Dependent Variable:	temp_change
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.1906
Min. group size:	2	Log-Likelihood:	-109.0103
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

-----

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.102	0.049	-2.080	0.037	-0.198	-0.006
sample_wt	0.047	0.052	0.901	0.368	-0.055	0.150
start_temp	-0.411	0.053	-7.817	0.000	-0.514	-0.308

sample_wt:start_temp	-0.264	0.055	-4.836	0.000	-0.371	-0.157
branching	0.168	0.043	3.882	0.000	0.083	0.253
stem_sav	-0.126	0.060	-2.089	0.037	-0.245	-0.008
thickness	-0.052	0.063	-0.817	0.414	-0.176	0.072
Group Var	0.000					
species:plant_id Var	0.044	0.066				

=====



#### Mixed Linear Model Regression Results

=====

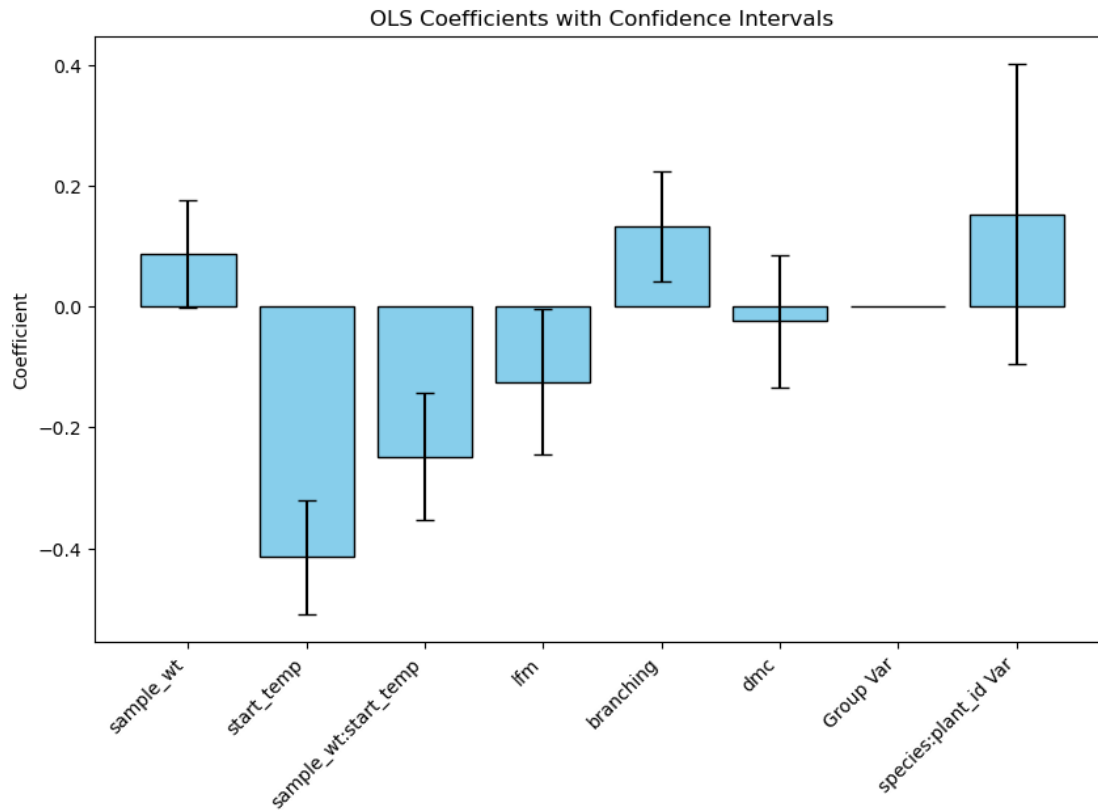
Model:	MixedLM	Dependent Variable:	temp_change
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.1997
Min. group size:	2	Log-Likelihood:	-109.0624
Max. group size:	37	Converged:	Yes
Mean group size:	20.2		

-----

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.091	0.046	-1.960	0.050	-0.182	-0.000
sample_wt	0.088	0.046	1.922	0.055	-0.002	0.177

start_temp	-0.415	0.048	-8.638	0.000	-0.509	-0.321
sample_wt:start_temp	-0.248	0.054	-4.627	0.000	-0.353	-0.143
lfm	-0.125	0.062	-2.024	0.043	-0.245	-0.004
branching	0.132	0.047	2.841	0.004	0.041	0.223
dmc	-0.024	0.056	-0.430	0.667	-0.133	0.085
Group Var	0.000					
species:plant_id Var	0.031	0.057				

=====



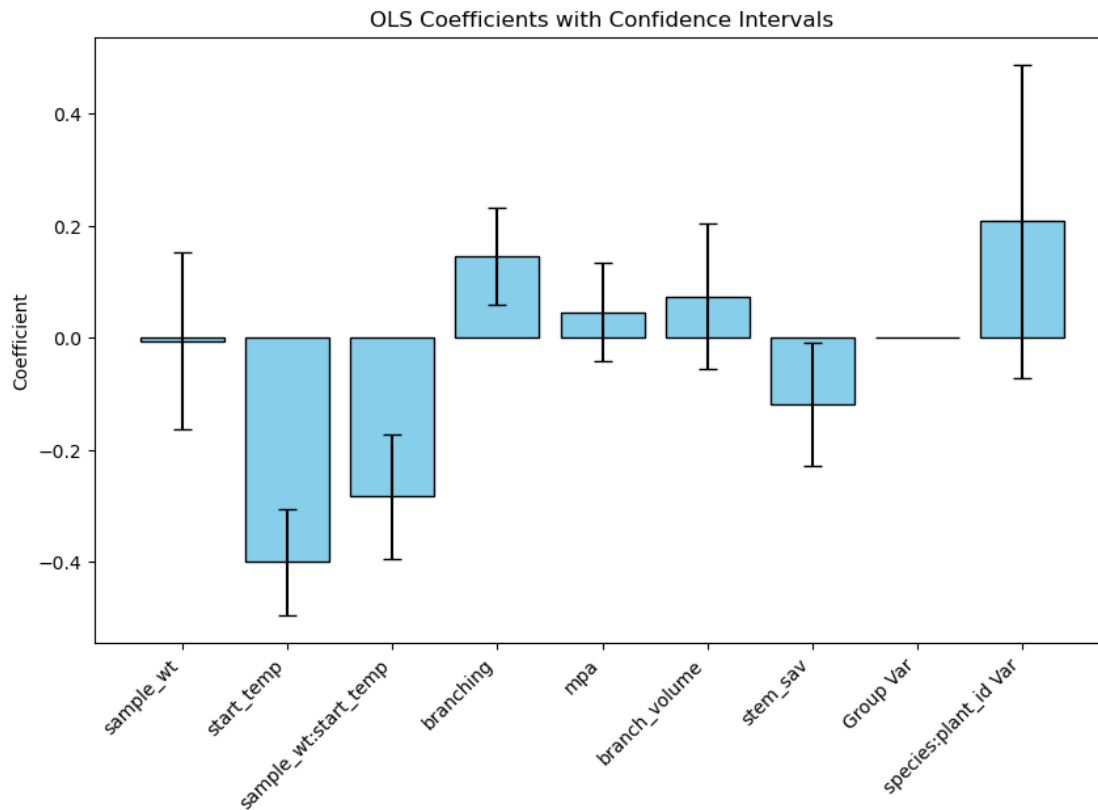
#### Mixed Linear Model Regression Results

Model:	MixedLM	Dependent Variable:	temp_change
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.1911
Min. group size:	2	Log-Likelihood:	-108.0762
Max. group size:	37	Converged:	No
Mean group size:	20.2		

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.103	0.048	-2.129	0.033	-0.197	-0.008

sample_wt	-0.006	0.081	-0.075	0.940	-0.165	0.153
start_temp	-0.400	0.048	-8.292	0.000	-0.495	-0.306
sample_wt:start_temp	-0.284	0.057	-4.991	0.000	-0.395	-0.172
branching	0.145	0.044	3.279	0.001	0.058	0.232
mpa	0.046	0.045	1.010	0.312	-0.043	0.134
branch_volume	0.074	0.066	1.119	0.263	-0.056	0.203
stem_sav	-0.119	0.056	-2.145	0.032	-0.228	-0.010
Group Var	0.000					
species:plant_id Var	0.040	0.062				

=====



#### Mixed Linear Model Regression Results

=====

Model:	MixedLM	Dependent Variable:	temp_change
No. Observations:	162	Method:	ML
No. Groups:	8	Scale:	0.1924
Min. group size:	2	Log-Likelihood:	-111.2144
Max. group size:	37	Converged:	No
Mean group size:	20.2		

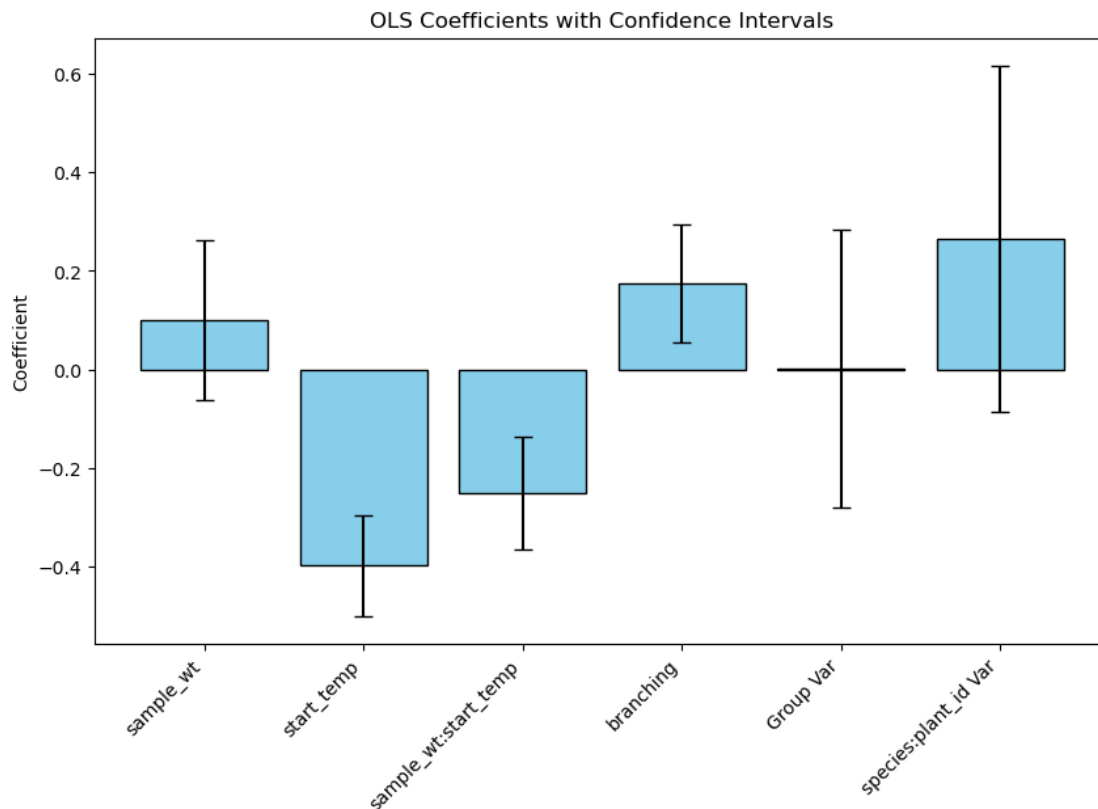
-----

Coef.	Std.Err.	z	P> z	[0.025	0.975]
-------	----------	---	------	--------	--------

```

-----
Intercept          -0.091    0.052 -1.758 0.079 -0.192  0.010
sample_wt           0.100    0.083  1.205 0.228 -0.063  0.262
start_temp        -0.398    0.052 -7.612 0.000 -0.501 -0.296
sample_wt:start_temp -0.251    0.059 -4.279 0.000 -0.366 -0.136
branching           0.175    0.061  2.870 0.004  0.055  0.294
Group Var           0.000    0.063
species:plant_id Var 0.051    0.079
=====

```



#### Mixed Linear Model Regression Results

```

=====
Model:              MixedLM   Dependent Variable:  temp_change
No. Observations:   162       Method:                 ML
No. Groups:         8         Scale:                0.1967
Min. group size:    2         Log-Likelihood:       -110.2737
Max. group size:    37       Converged:             Yes
Mean group size:    20.2

```

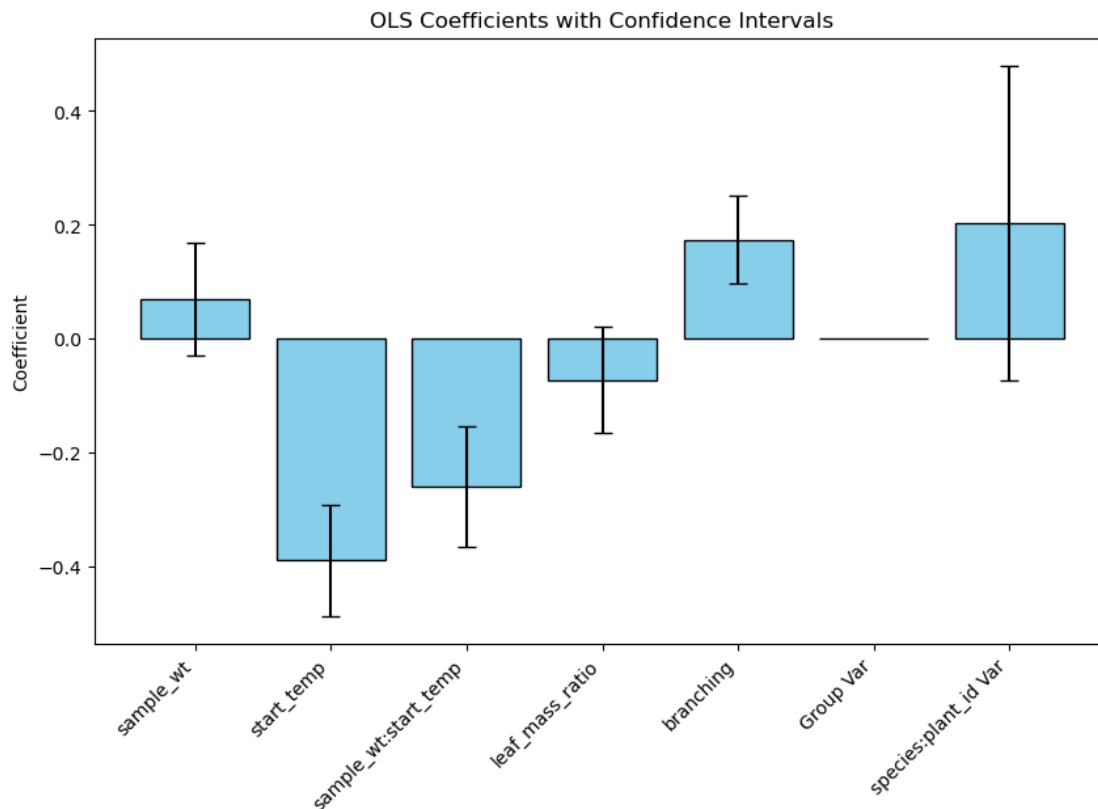
```

-----
Coef.  Std.Err.  z    P>|z|  [0.025  0.975]
-----

```

Intercept	-0.097	0.048	-2.012	0.044	-0.191	-0.002
sample_wt	0.070	0.050	1.393	0.164	-0.029	0.169
start_temp	-0.389	0.050	-7.825	0.000	-0.486	-0.291
sample_wt:start_temp	-0.259	0.054	-4.765	0.000	-0.366	-0.153
leaf_mass_ratio	-0.072	0.048	-1.517	0.129	-0.166	0.021
branching	0.175	0.039	4.431	0.000	0.097	0.252
Group Var	0.000					
species:plant_id Var	0.040	0.062				

=====



## 7 Heat Flux Change

```
[13]: yvar='heat_flux_change'
      cols=cols_use
      df=flam
      compare_predictors_mixedeff(df, cols, yvar)
```

	cols	aics	pvals	coefs	top_mod
0	thickness	412.755489	0.018575	8.731548e-01	True
1	mpa	411.997205	-0.076142	3.758305e-01	True

2	dmc	410.897627	0.147214	1.630031e-01	True
3	branching	410.177288	0.127608	1.048537e-01	False
4	leaf_mass_ratio	410.129840	-0.209494	8.185376e-02	False
5	leaf_sav	409.878494	-0.232572	8.228504e-02	False
6	start_temp	408.717362	0.185878	4.241968e-02	False
7	lfm	407.170292	-0.341791	1.955246e-02	False
8	stem_sav	405.824626	-0.375070	1.278106e-03	False
9	LMA	394.396642	0.515376	2.286915e-06	False
10	branch_volume	384.376755	0.397924	7.332081e-09	False
11	sample_wt	329.865131	0.683418	1.428780e-20	False

```
[14]: AIC_iterator(flam, cols_use, Y_VAR='heat_flux_change',
                 minnumsingle=mns, maxnumsingle=mxs, minnumint=mni, maxnumint=mxl)
```

ERROR: Formula model error: heat\_flux\_change ~ leaf\_sav\*thickness

Columns present in sig. interaction terms: {'start\_temp', 'sample\_wt'}

Total Num. Cols : Num. Sig. Int. Cols; 12 : 2

Significant Interactions:  
('sample\_wt', 'start\_temp')

Number of formulas: 1024

```
heat_flux_change ~ sample_wt*start_temp + LMA
heat_flux_change ~ sample_wt*start_temp + LMA + leaf_mass_ratio
heat_flux_change ~ sample_wt*start_temp + LMA + branching
heat_flux_change ~ sample_wt*start_temp + LMA + thickness
heat_flux_change ~ sample_wt*start_temp + lfm + LMA
heat_flux_change ~ sample_wt*start_temp + LMA + leaf_mass_ratio + dmc
heat_flux_change ~ sample_wt*start_temp + LMA + stem_sav
heat_flux_change ~ sample_wt*start_temp + LMA + leaf_sav
heat_flux_change ~ sample_wt*start_temp + LMA + leaf_mass_ratio + thickness
heat_flux_change ~ sample_wt*start_temp + LMA + mpa
heat_flux_change ~ sample_wt*start_temp + LMA + branch_volume
heat_flux_change ~ sample_wt*start_temp + lfm + LMA + leaf_mass_ratio
heat_flux_change ~ sample_wt*start_temp + LMA + dmc
```

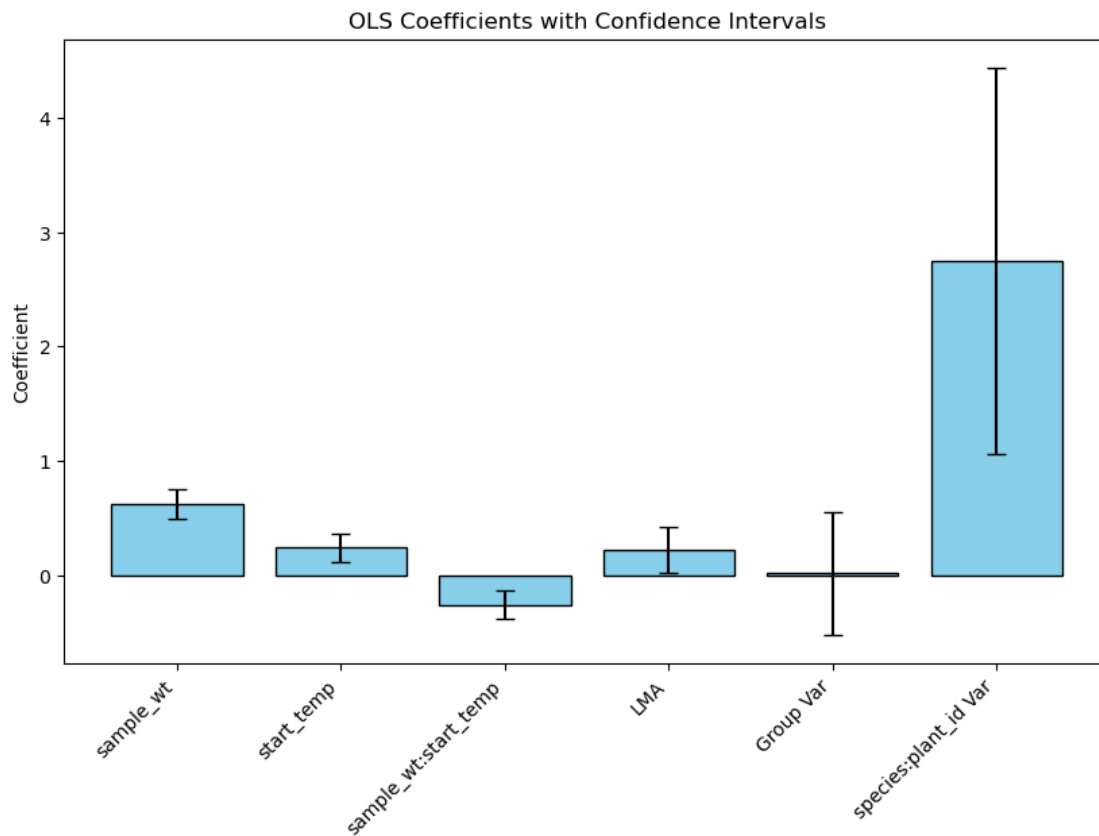
#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8       Scale:                0.1730
Min. group size:     2       Log-Likelihood:   -143.5655
Max. group size:     37      Converged:         Yes
```



Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.115	0.107	-1.070	0.285	-0.325	0.096
sample_wt	0.623	0.067	9.249	0.000	0.491	0.755
start_temp	0.241	0.063	3.856	0.000	0.119	0.364
sample_wt:start_temp	-0.257	0.065	-3.938	0.000	-0.385	-0.129
LMA	0.222	0.104	2.128	0.033	0.018	0.427
Group Var	0.003	0.114				
species:plant_id Var	0.476	0.358				

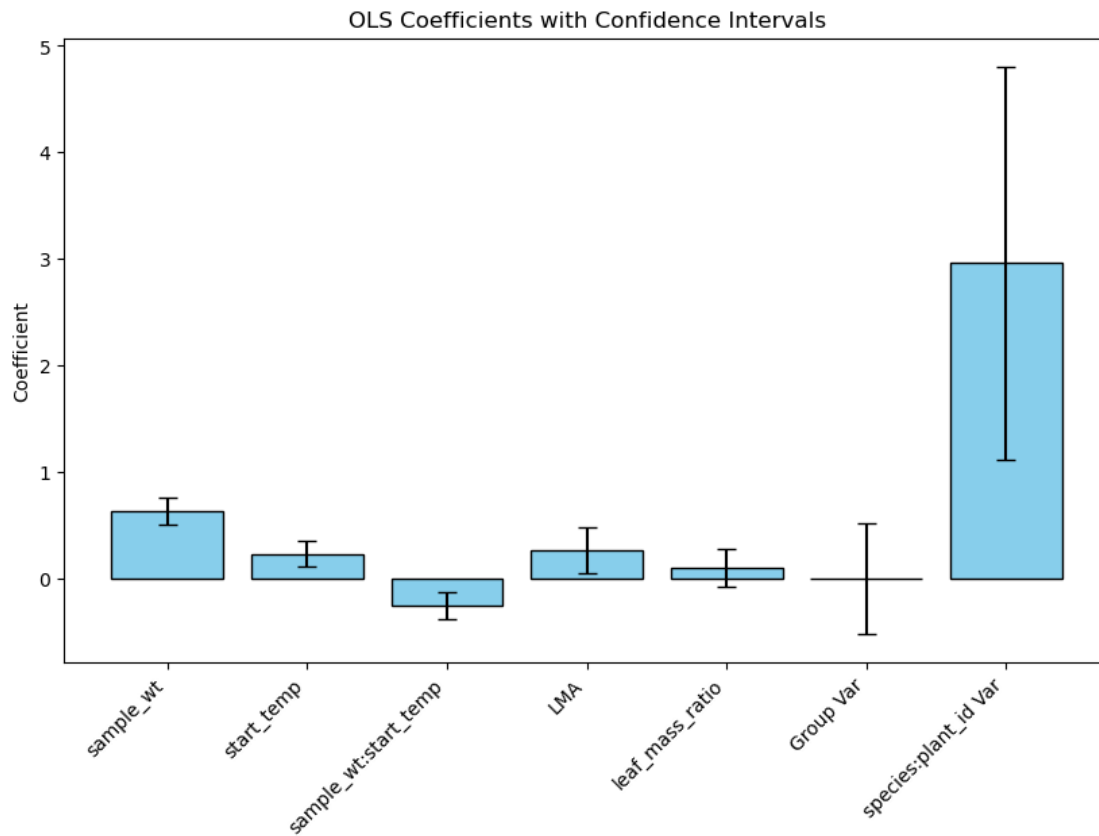


#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162    Method:                ML
No. Groups:          8      Scale:                0.1683
Min. group size:     2      Log-Likelihood:    -142.9470
Max. group size:     37     Converged:          Yes
=====
```

Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.114	0.107	-1.064	0.287	-0.324	0.096
sample_wt	0.632	0.066	9.571	0.000	0.503	0.761
start_temp	0.232	0.062	3.730	0.000	0.110	0.355
sample_wt:start_temp	-0.258	0.065	-3.989	0.000	-0.385	-0.131
LMA	0.265	0.112	2.374	0.018	0.046	0.484
leaf_mass_ratio	0.101	0.091	1.109	0.267	-0.077	0.279
Group Var	0.000	0.109				
species:plant_id Var	0.499	0.386				

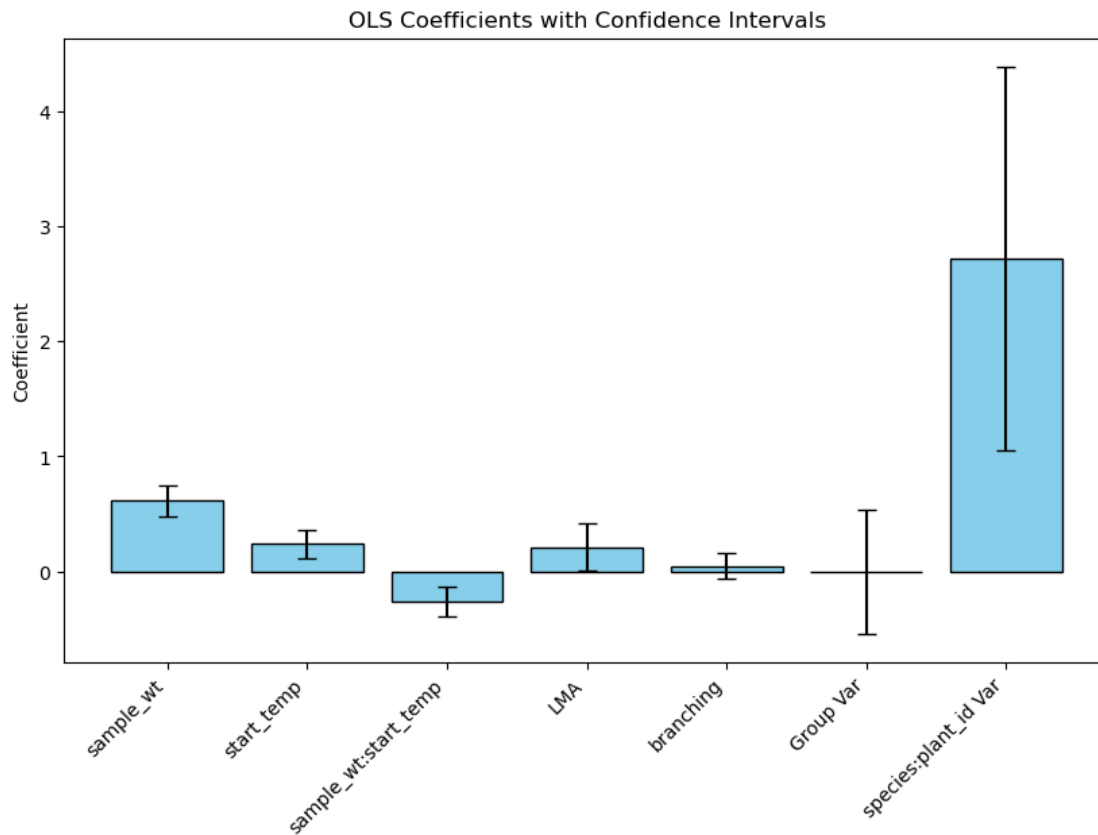


#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8       Scale:                0.1729
Min. group size:     2      Log-Likelihood:    -143.1523
```

Max. group size: 37      Converged:      Yes  
Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.110	0.105	-1.050	0.294	-0.315	0.095
sample_wt	0.616	0.068	9.078	0.000	0.483	0.749
start_temp	0.240	0.062	3.855	0.000	0.118	0.362
sample_wt:start_temp	-0.258	0.065	-3.949	0.000	-0.387	-0.130
LMA	0.211	0.104	2.025	0.043	0.007	0.416
branching	0.049	0.055	0.896	0.370	-0.058	0.156
Group Var	0.000	0.115				
species:plant_id Var	0.471	0.354				

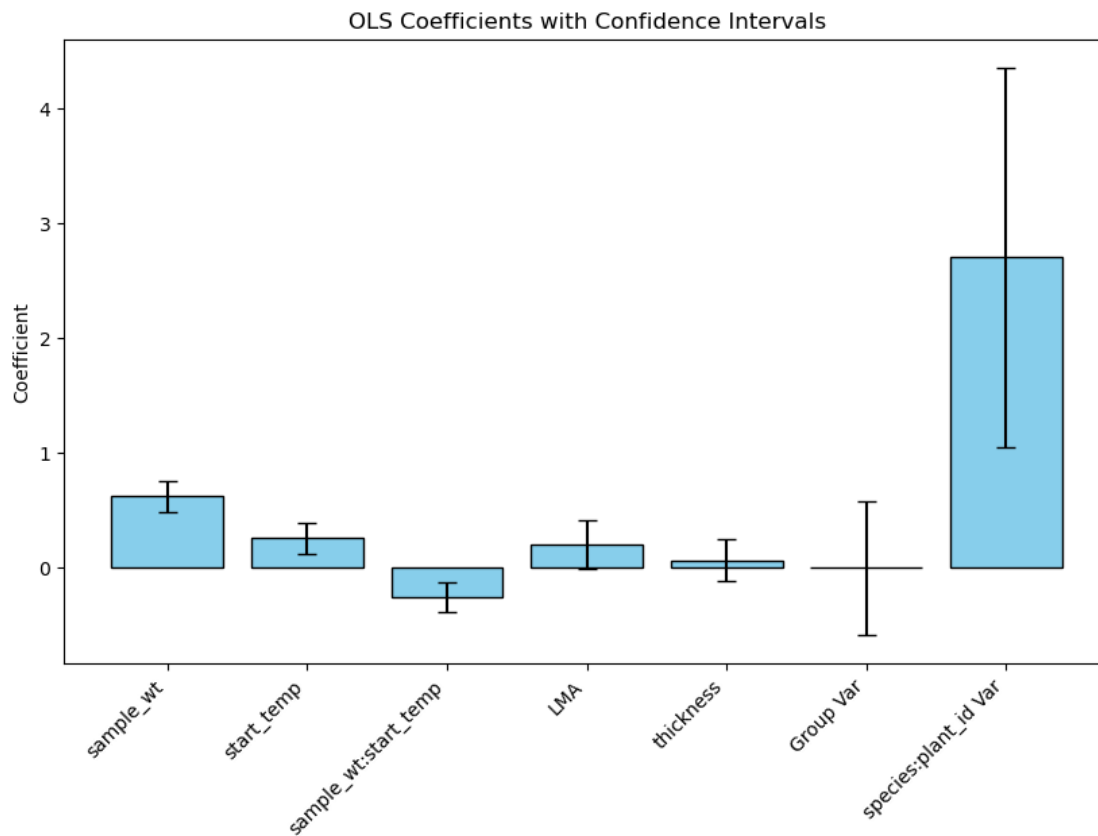


#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8       Scale:                0.1736
```

Min. group size: 2      Log-Likelihood: -143.2780  
 Max. group size: 37      Converged: Yes  
 Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.109	0.105	-1.038	0.299	-0.315	0.097
sample_wt	0.622	0.068	9.121	0.000	0.488	0.755
start_temp	0.260	0.068	3.801	0.000	0.126	0.394
sample_wt:start_temp	-0.254	0.066	-3.845	0.000	-0.383	-0.124
LMA	0.206	0.107	1.922	0.055	-0.004	0.416
thickness	0.067	0.092	0.730	0.466	-0.113	0.248
Group Var	0.000	0.123				
species:plant_id Var	0.469	0.351				

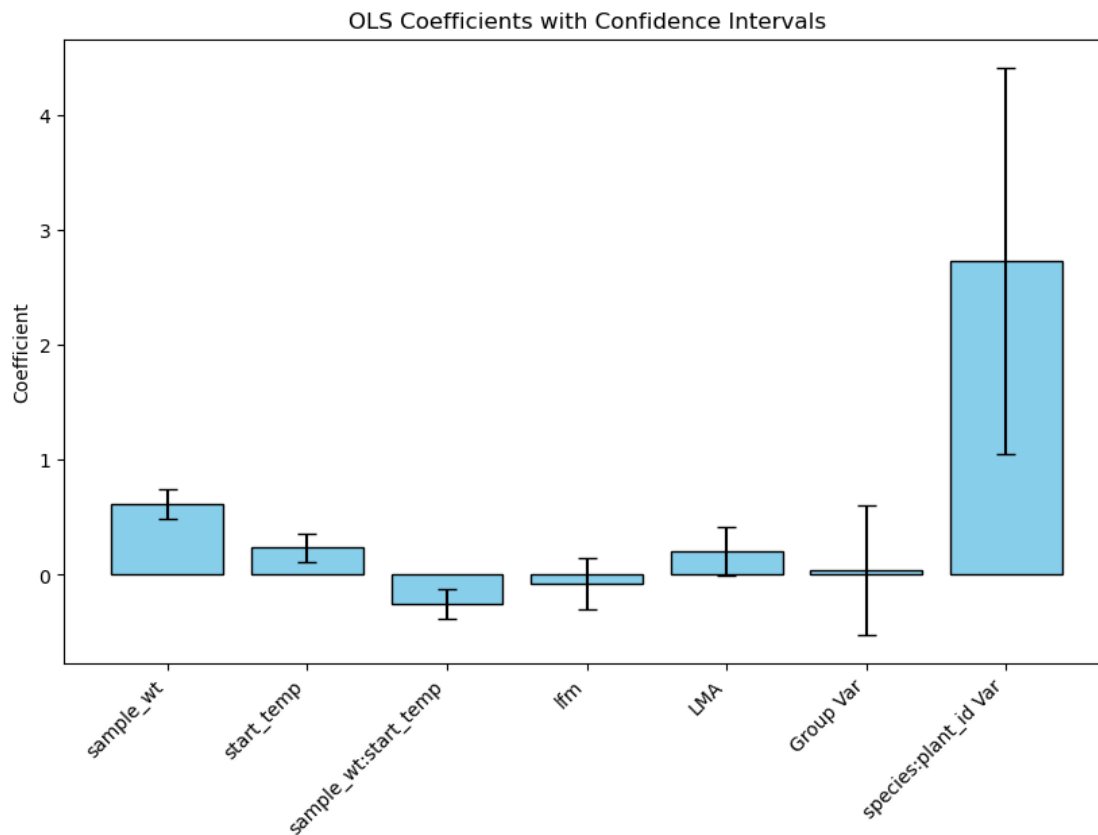


#### Mixed Linear Model Regression Results

Model: MixedLM Dependent Variable: heat\_flux\_change  
 No. Observations: 162 Method: ML

No. Groups: 8 Scale: 0.1724  
 Min. group size: 2 Log-Likelihood: -143.3172  
 Max. group size: 37 Converged: Yes  
 Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.111	0.109	-1.018	0.309	-0.324	0.103
sample_wt	0.619	0.067	9.199	0.000	0.487	0.751
start_temp	0.237	0.063	3.784	0.000	0.114	0.360
sample_wt:start_temp	-0.257	0.065	-3.958	0.000	-0.385	-0.130
lfm	-0.077	0.111	-0.692	0.489	-0.295	0.141
LMA	0.203	0.108	1.883	0.060	-0.008	0.415
Group Var	0.007	0.119				
species:plant_id Var	0.471	0.357				

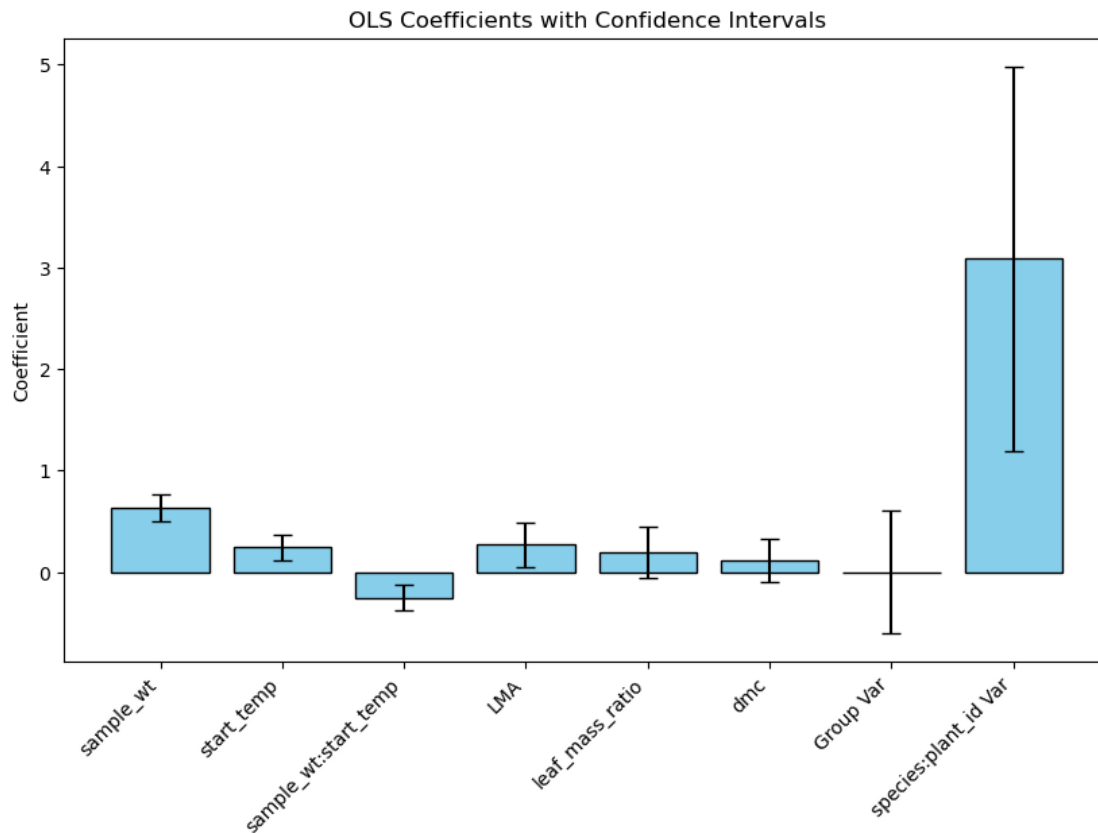


#### Mixed Linear Model Regression Results

Model: MixedLM Dependent Variable: heat\_flux\_change

No. Observations: 162      Method: ML  
 No. Groups: 8      Scale: 0.1653  
 Min. group size: 2      Log-Likelihood: -142.4004  
 Max. group size: 37      Converged: Yes  
 Mean group size: 20.2

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.108	0.108	-1.000	0.317	-0.318	0.103
sample_wt	0.631	0.066	9.576	0.000	0.502	0.760
start_temp	0.241	0.063	3.851	0.000	0.118	0.364
sample_wt:start_temp	-0.256	0.065	-3.962	0.000	-0.383	-0.129
LMA	0.270	0.111	2.434	0.015	0.053	0.488
leaf_mass_ratio	0.197	0.130	1.513	0.130	-0.058	0.452
dmc	0.111	0.109	1.022	0.307	-0.102	0.325
Group Var	0.000	0.125				
species:plant_id Var	0.510	0.393				



Mixed Linear Model Regression Results

```

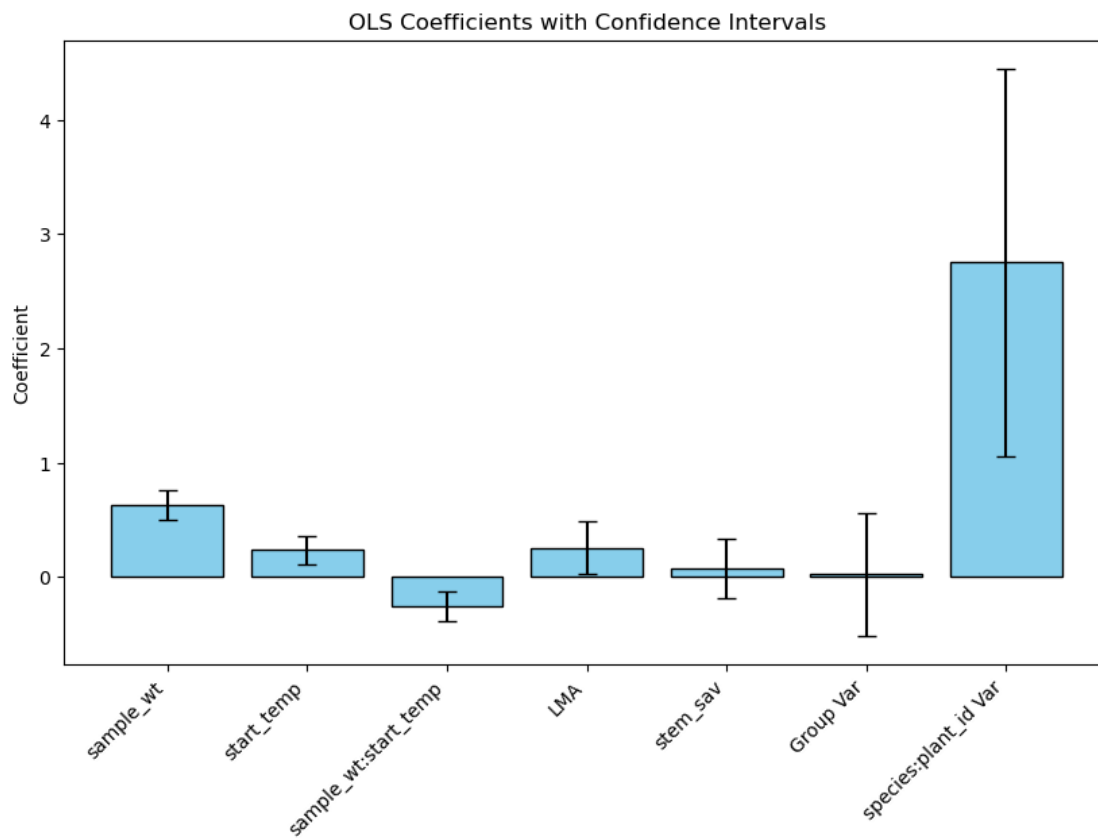
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8       Scale:              0.1726
Min. group size:     2       Log-Likelihood:   -143.4082
Max. group size:     37      Converged:         Yes
Mean group size:     20.2
=====

```

```

-----
                Coef.  Std.Err.   z    P>|z| [0.025 0.975]
-----
Intercept          -0.109    0.109  -1.001  0.317  -0.322  0.104
sample_wt           0.628    0.067   9.303  0.000   0.496  0.760
start_temp          0.237    0.063   3.760  0.000   0.113  0.360
sample_wt:start_temp -0.258    0.065  -3.951  0.000  -0.386 -0.130
LMA                 0.253    0.118   2.143  0.032   0.022  0.485
stem_sav            0.074    0.134   0.554  0.580  -0.189  0.337
Group Var           0.004    0.114
species:plant_id Var 0.475    0.359
=====

```



# Mixed Linear Model Regression Results

```

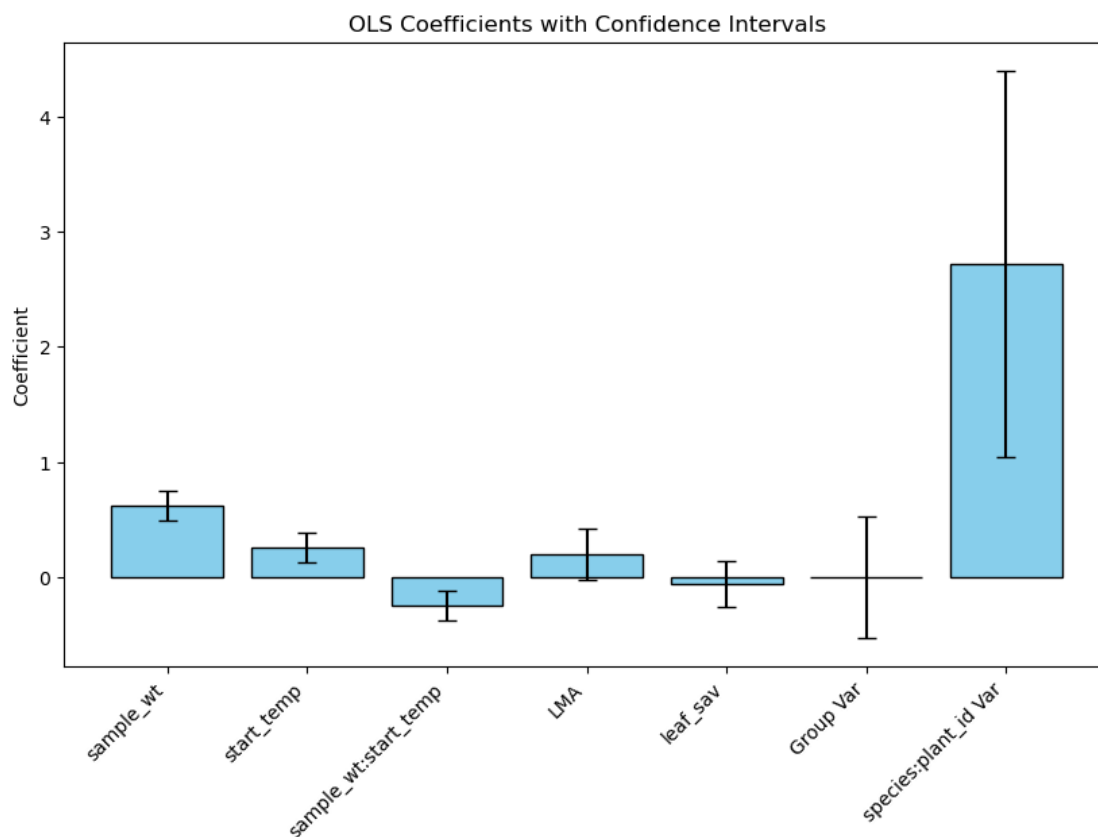
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8        Scale:               0.1735
Min. group size:     2        Log-Likelihood:   -143.4101
Max. group size:     37      Converged:          Yes
Mean group size:     20.2
=====

```

```

-----
              Coef.  Std.Err.   z    P>|z| [0.025 0.975]
-----
Intercept          -0.114    0.105 -1.082 0.279 -0.320  0.092
sample_wt           0.619    0.068  9.123 0.000  0.486  0.752
start_temp          0.253    0.066  3.823 0.000  0.123  0.383
sample_wt:start_temp -0.254    0.066 -3.858 0.000 -0.382 -0.125
LMA                 0.198    0.113  1.758 0.079 -0.023  0.419
leaf_sav            -0.057    0.102 -0.558 0.577 -0.257  0.143
Group Var           0.000    0.112
species:plant_id Var 0.472    0.357
=====

```





# Mixed Linear Model Regression Results

```

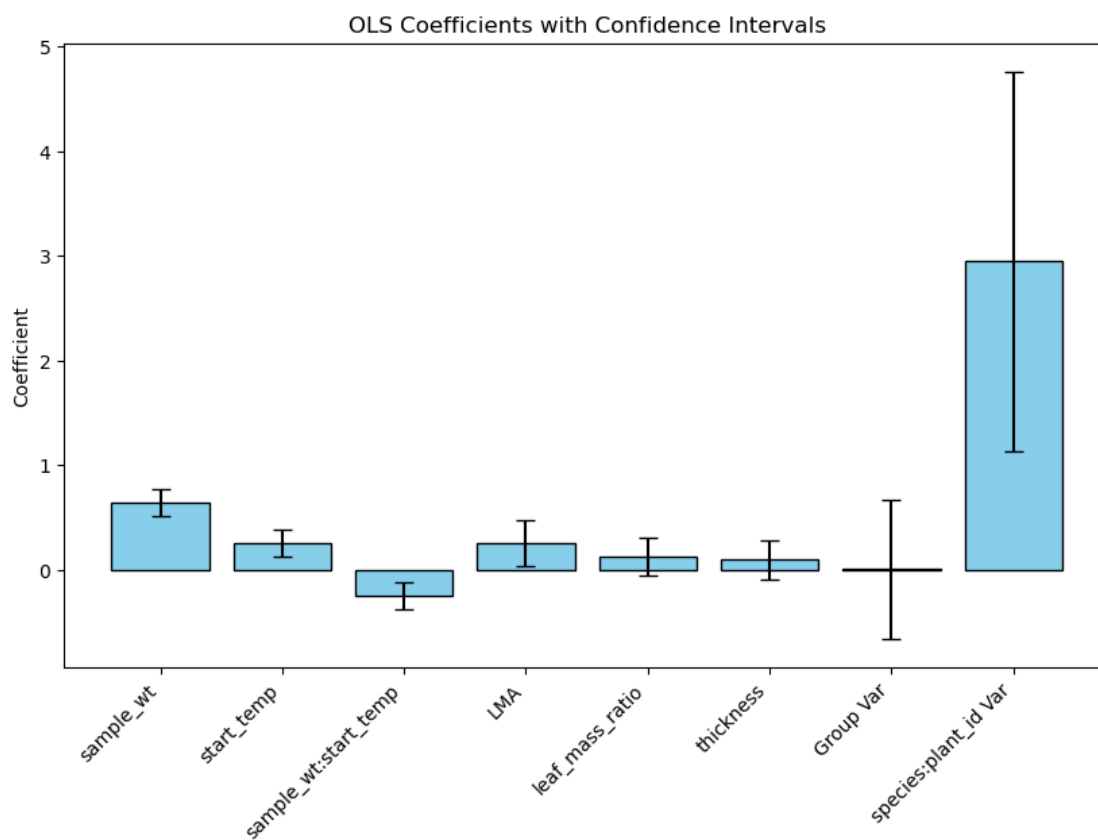
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8        Scale:               0.1676
Min. group size:     2        Log-Likelihood:   -142.4251
Max. group size:     37       Converged:         Yes
Mean group size:     20.2
=====

```

```

-----
              Coef.  Std.Err.   z    P>|z|  [0.025 0.975]
-----
Intercept          -0.104    0.106 -0.976 0.329  -0.313  0.105
sample_wt           0.634    0.066  9.566 0.000   0.504  0.764
start_temp          0.255    0.067  3.802 0.000   0.124  0.387
sample_wt:start_temp -0.255    0.066 -3.881 0.000  -0.384 -0.126
LMA                 0.253    0.114  2.227 0.026   0.030  0.476
leaf_mass_ratio      0.121    0.093  1.305 0.192  -0.061  0.304
thickness            0.092    0.096  0.956 0.339  -0.097  0.281
Group Var           0.000    0.138
species:plant_id Var 0.493    0.379
=====

```



### Mixed Linear Model Regression Results

```

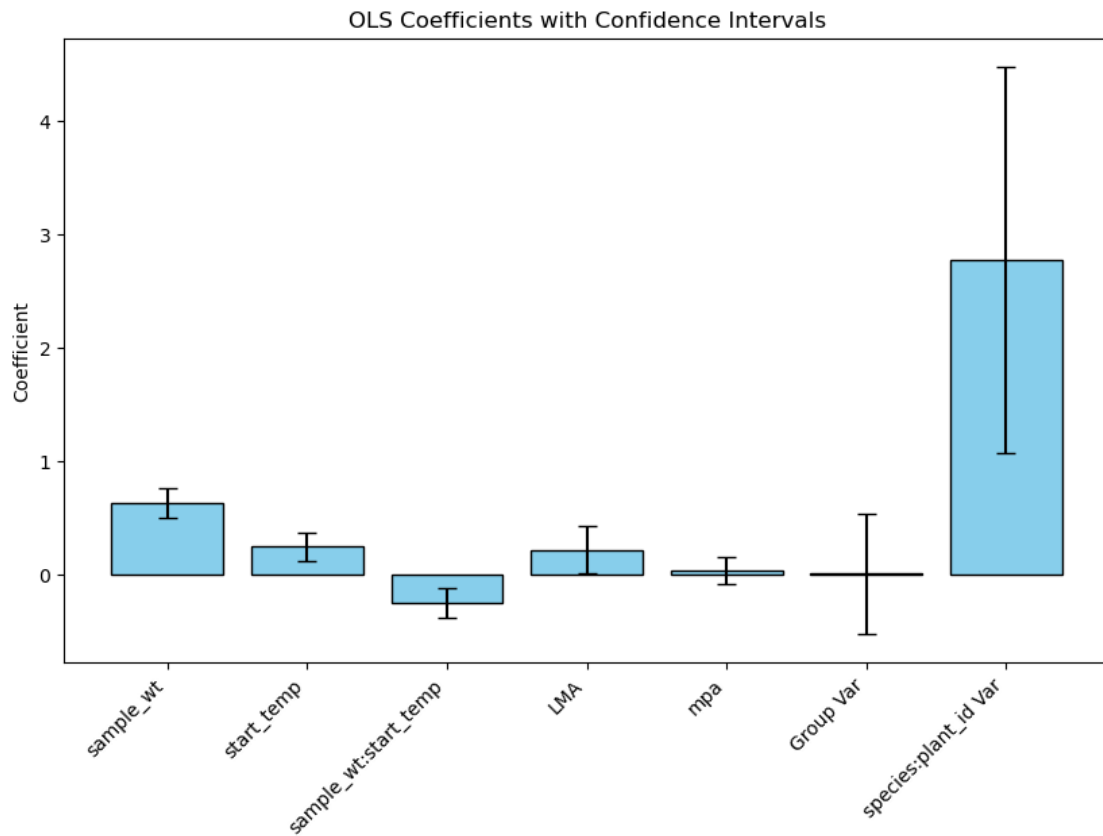
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8        Scale:               0.1726
Min. group size:     2        Log-Likelihood:    -143.4378
Max. group size:     37       Converged:          Yes
Mean group size:     20.2
=====

```

```

-----
              Coef.  Std.Err.   z    P>|z| [0.025 0.975]
-----
Intercept          -0.111    0.106 -1.045 0.296 -0.319  0.097
sample_wt           0.629    0.068  9.201 0.000  0.495  0.763
start_temp          0.243    0.062  3.897 0.000  0.121  0.365
sample_wt:start_temp -0.253    0.066 -3.840 0.000 -0.382 -0.124
LMA                 0.217    0.104  2.073 0.038  0.012  0.421
mpa                 0.030    0.059  0.506 0.613 -0.086  0.145
Group Var           0.001    0.112
species:plant_id Var 0.478    0.361
=====

```



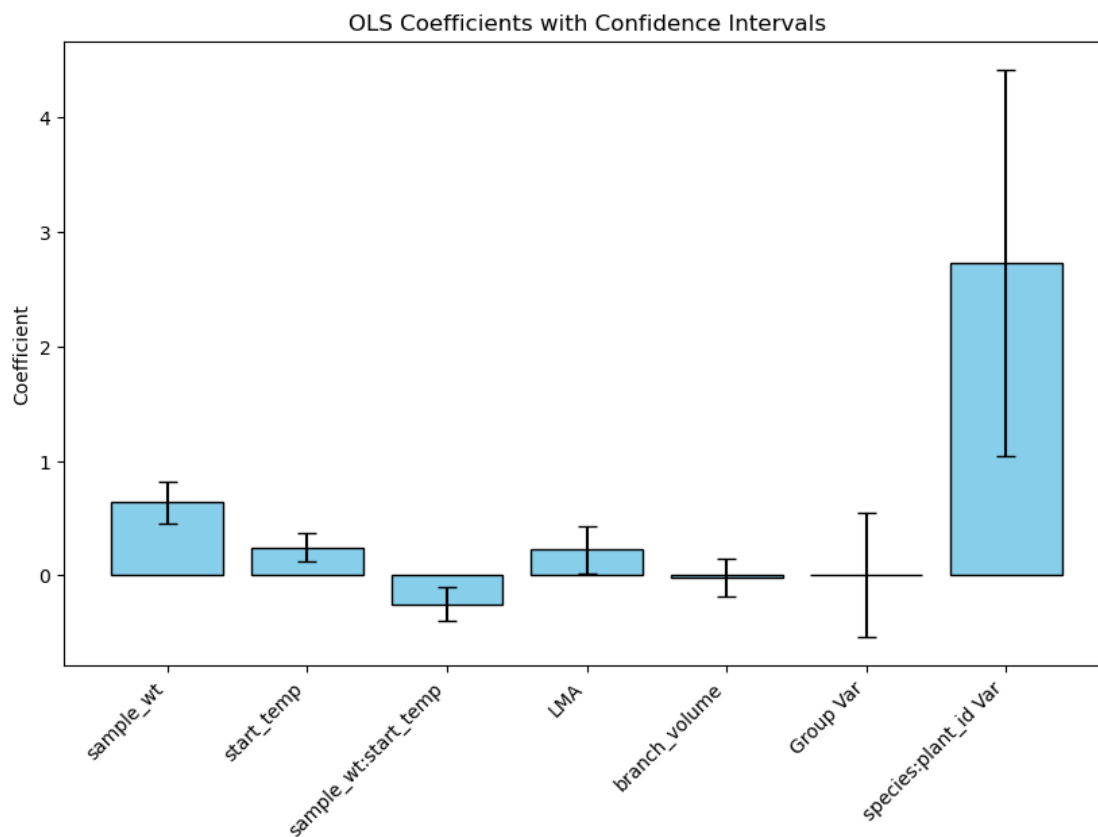
# Mixed Linear Model Regression Results

```

=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8       Scale:                0.1735
Min. group size:     2       Log-Likelihood:   -143.5438
Max. group size:     37      Converged:         Yes
Mean group size:     20.2
=====

```

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Intercept	-0.114	0.106	-1.078	0.281	-0.321	0.093
sample_wt	0.636	0.092	6.887	0.000	0.455	0.817
start_temp	0.244	0.063	3.836	0.000	0.119	0.368
sample_wt:start_temp	-0.250	0.073	-3.440	0.001	-0.393	-0.108
LMA	0.224	0.104	2.149	0.032	0.020	0.428
branch_volume	-0.017	0.083	-0.208	0.835	-0.180	0.146
Group Var	0.001	0.115				
species:plant_id Var	0.474	0.358				



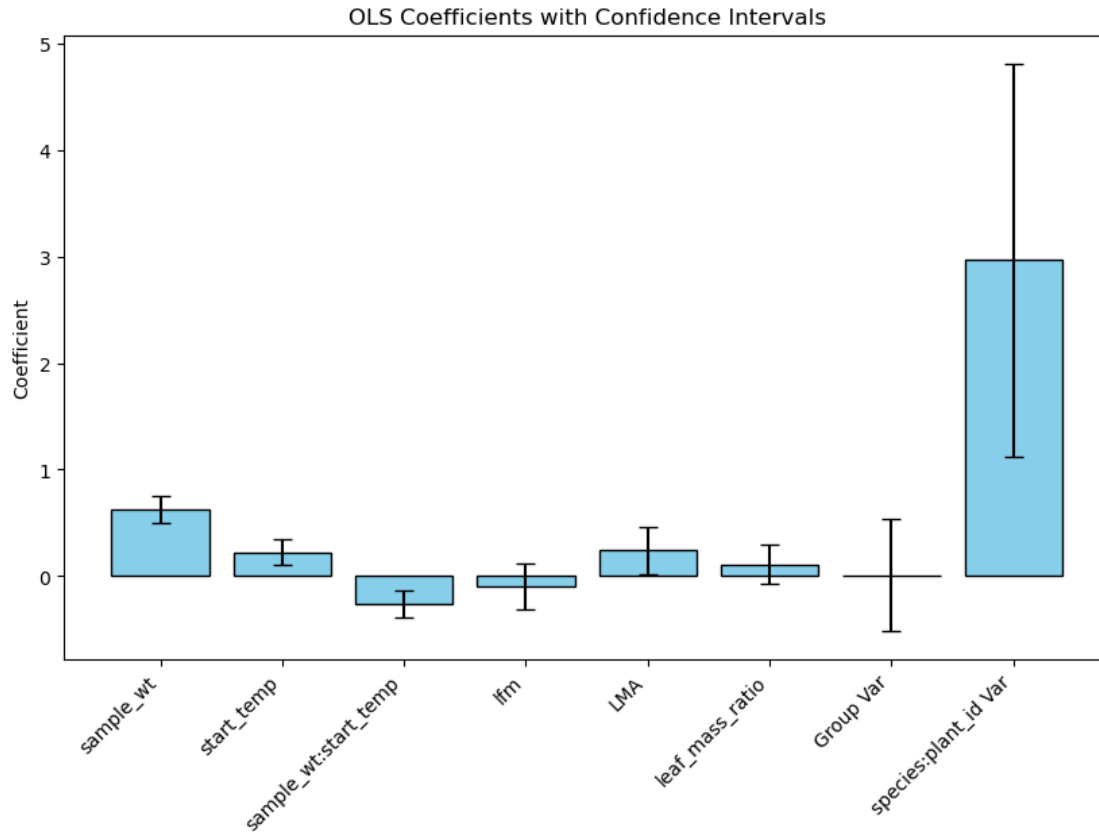
# Mixed Linear Model Regression Results

```

=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:          8        Scale:                0.1674
Min. group size:     2        Log-Likelihood:      -142.5567
Max. group size:     37      Converged:            Yes
Mean group size:     20.2

-----
              Coef.  Std.Err.   z    P>|z| [0.025 0.975]
-----
Intercept          -0.109    0.107  -1.015  0.310  -0.319  0.101
sample_wt           0.627    0.066   9.527  0.000   0.498  0.756
start_temp          0.226    0.062   3.620  0.000   0.104  0.348
sample_wt:start_temp -0.258    0.064  -4.000  0.000  -0.384 -0.132
lfm                 -0.097    0.111  -0.872  0.383  -0.315  0.121
LMA                 0.245    0.113   2.164  0.030   0.023  0.467
leaf_mass_ratio     0.113    0.092   1.234  0.217  -0.067  0.293
Group Var           0.002    0.109
species:plant_id Var 0.496    0.385
=====

```



#### Mixed Linear Model Regression Results

```
=====
Model:                MixedLM Dependent Variable: heat_flux_change
No. Observations:    162      Method:                ML
No. Groups:           8       Scale:              0.1730
Min. group size:      2       Log-Likelihood:   -143.5633
Max. group size:      37      Converged:        Yes
Mean group size:      20.2
=====
```

```
-----
              Coef.  Std.Err.   z    P>|z| [0.025 0.975]
-----
Intercept          -0.115    0.108 -1.067 0.286 -0.326  0.096
sample_wt           0.623    0.068  9.171 0.000  0.490  0.756
start_temp          0.240    0.064  3.759 0.000  0.115  0.366
sample_wt:start_temp -0.257    0.065 -3.934 0.000 -0.386 -0.129
LMA                 0.224    0.108  2.081 0.037  0.013  0.435
dmc                -0.005    0.076 -0.068 0.946 -0.154  0.144
Group Var           0.003    0.115
species:plant_id Var 0.476    0.359
=====
```

