Effects of elevation and heat load on the landscape-scale distribution of male and female trees in aspen (Populus tremuloides)

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EXTENSION
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Quaking Aspen (*Populus tremuloides*) – Flowers, Twig, and Seeds

Aspen on the Landscape

- Vegetative reproduction from root suckers[1,2]
- Stand replacing disturbance[3,4]

Aspen Decline and Future Range

Photo Credit – Rocky Mountain Research Station (Ft. Collins, CO)

- Grazing/browsing pressure[5,6]
- Fire suppression[7]
- Climate change related drought[8,9]

Aspen Distribution Literature

Photo Credit – Rick Wicker

- Described at local scale[10,11,12]
- Genetic and geographic history[13,14]
- Focus on large mortality events[15,16]

Aspen Sex Distribution – Grant/Mitton (1979)

Elevation Range	1,700 – 2,450m	2,450 – 2,900m	2,900 – 3,100m
Percent Female, Number of Sample Sites	56%, (52)	46%, (94)	36%, (52)

Data Credit – Grant and Mitton 1979

- Male/Female spatial segregation by elevation
- Individual sex recorded in the field

Research Question:

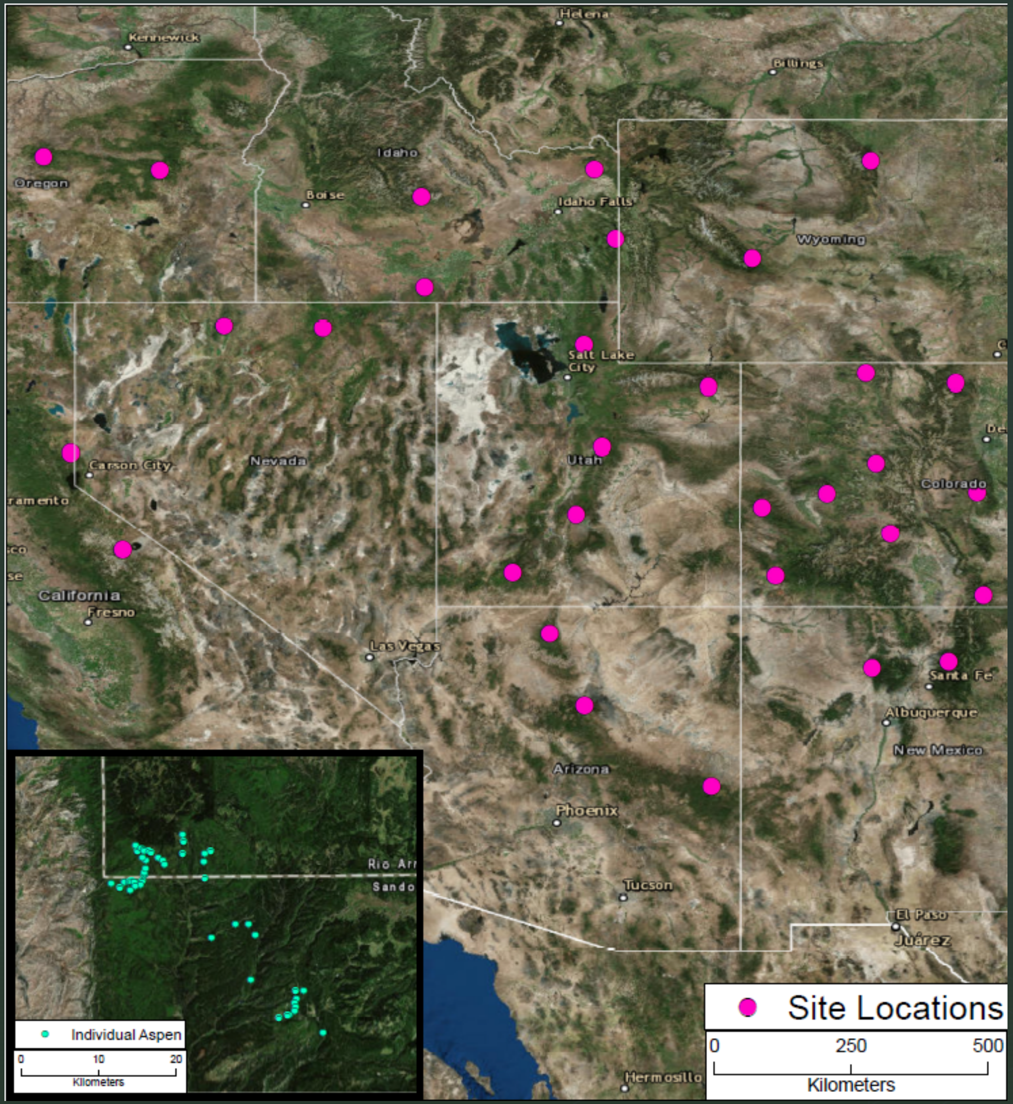
Do aspen sex ratios change with elevation and heat load index?

Hypothesis:

The overall sex ratio of aspen genets on the landscape will be male-biased, both at higher elevations and at sites with a greater heat load index

Site Location and Field Collection

- 32 total sites
- 21-50 samples per site (1452 total)
- Broad elevation gradient
- Wet/dry moisture categories



Lab Portion – Determining Sex

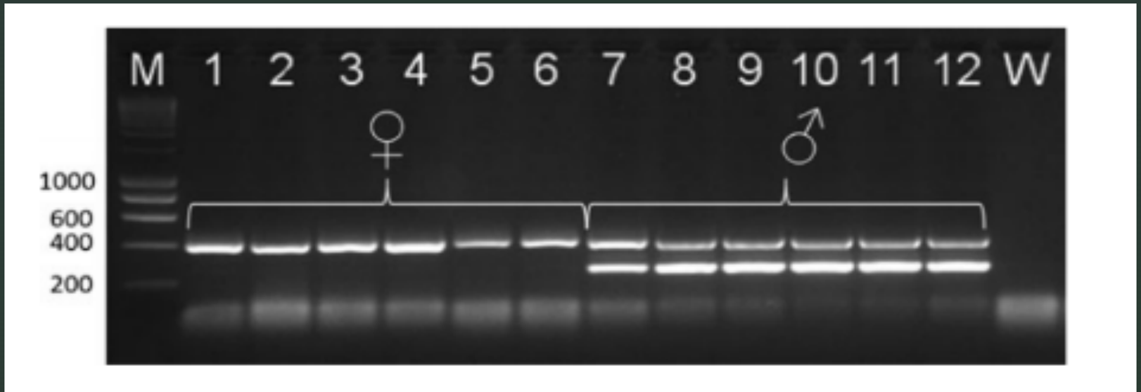
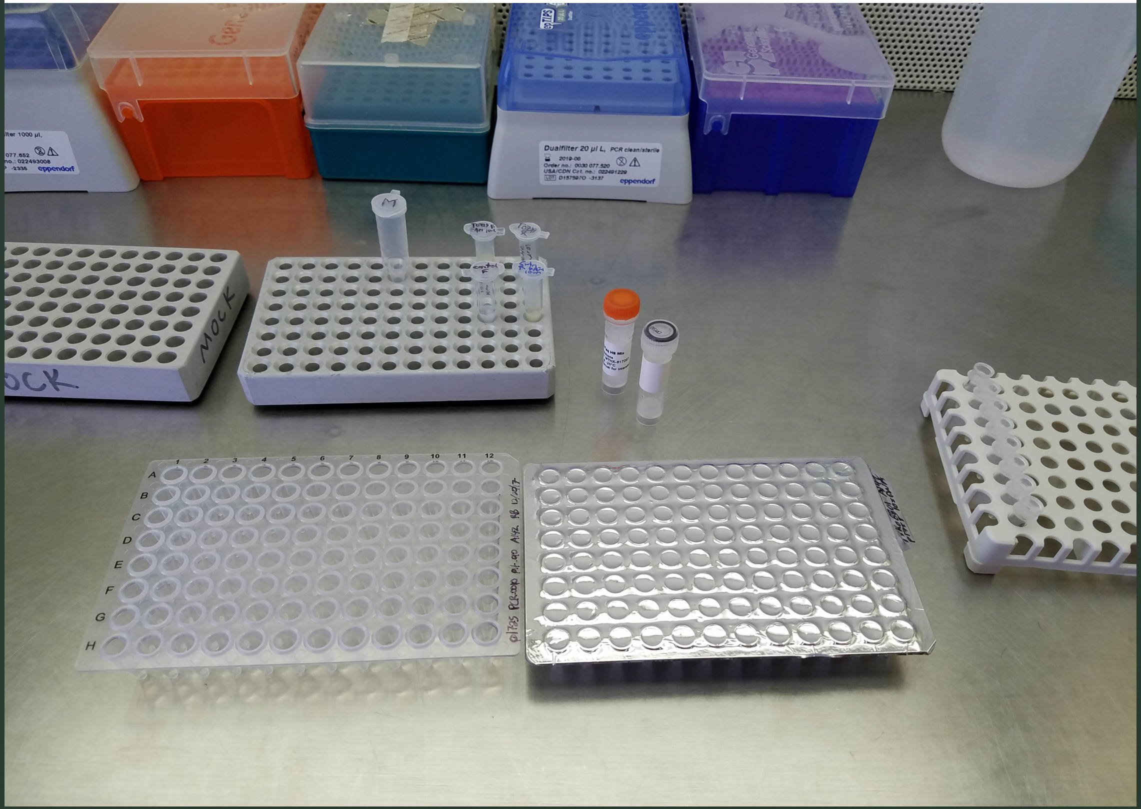


Figure Credit - Pakull *et al.* 2014



- Using genetic markers[17]
- Clear and easily interpreted results

Data + Methods

Sample Name	Score_M1_F0	Aspect	Slope	Latitude (°)	Longitude (°)	Elevation (m)
COM1601	0	101.9689	21.70365	39.36802	-106.815	2348
COM1602	0	193.7849	18.61226	39.37673	-106.811	2449
COM1603	1	306.391	26.95446	39.38447	-106.804	2521
COM1604	0	145.5128	11.01114	39.38263	-106.795	2573
COM1605	1	271.7466	21.68808	39.37843	-106.785	2508

- Aspect and slope extracted with ArcMap 10.6.1
- Heat load index calculated from radian aspect, slope, and latitude[18]

Bayesian Model

```
genmodel = textConnection("model{

              for (i in 1:N){

              ## bernoulli sampling distribution
              y[i] ~ dbern(p[i])

              ## link function and linear model
              logit(p[i]) <- beta[1] +
                             beta[2] * elvm[i] +
                             beta[3] * heatl[i] +
                             beta[4] * site[i] +
                             beta[5] * lat[i] +
                             beta[6] * elvm[i] * heatl[i]
              }

              ## uninformative priors for regression coefficients
              for (j in 1:6){
              beta[j] ~ dnorm(0, 1e-6)
              }

              }")
```

- Binomial (Bernoulli) GLM
- Elevation, heatload, site, latitude, interaction term
- Uninformative priors

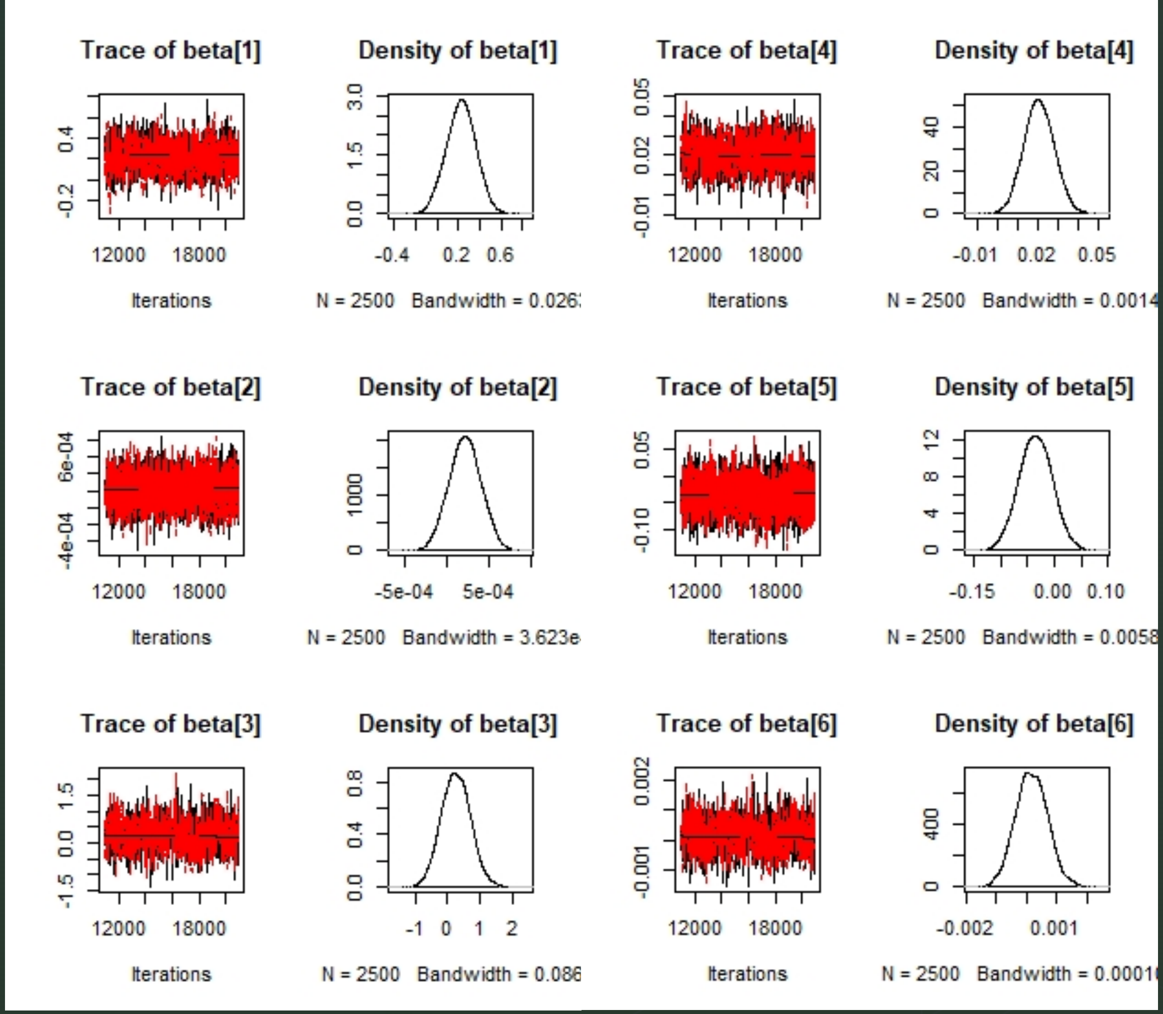
Model Analysis

- Iterations = 10000
- # Chains = 2
- Thin = 4

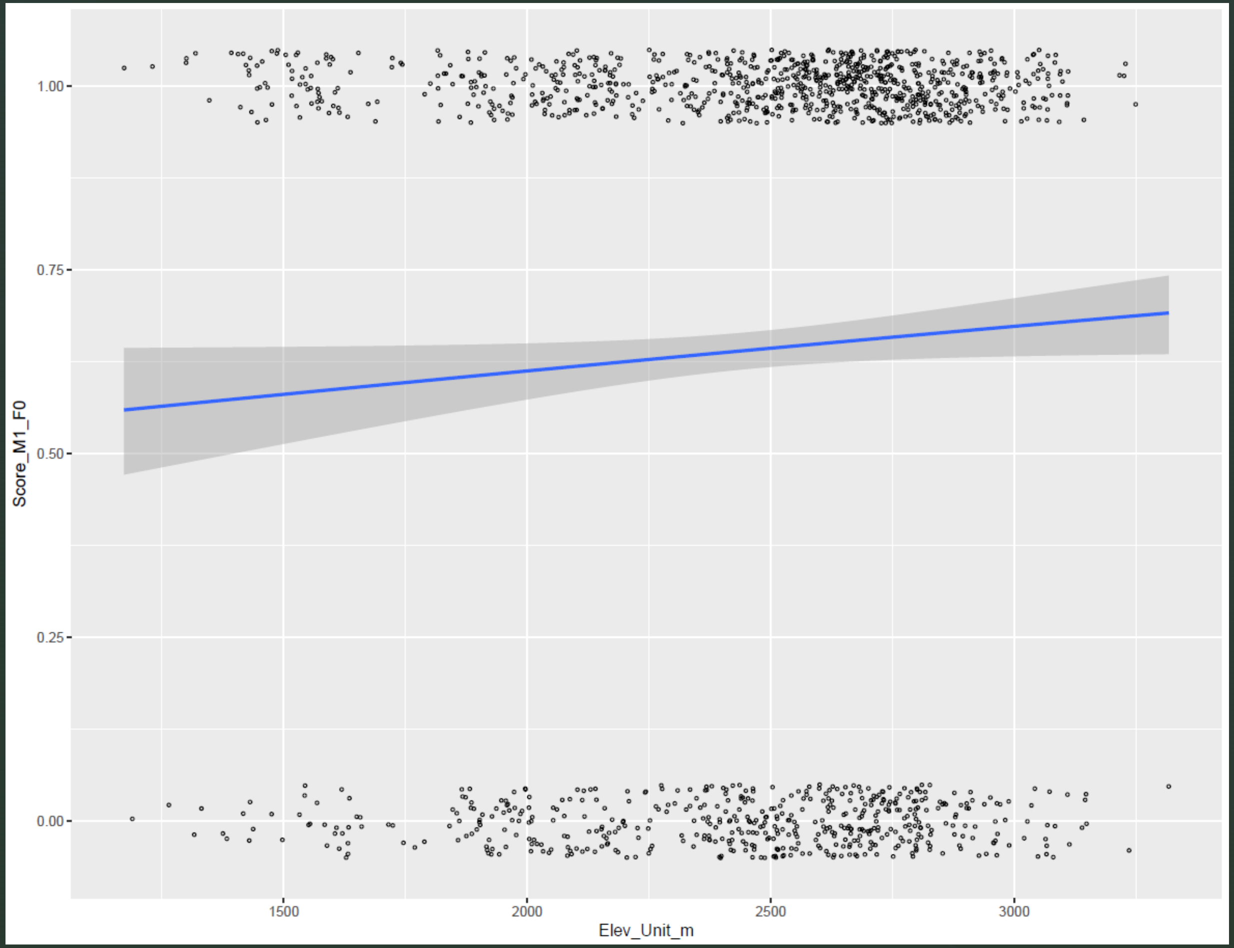
- Gelman Diagnostic
- Effective Size

2. Quantiles for each variable:

	2.5%	5%	50%	95%	97.5%
beta[1]	-0.0410548	-2.590e-03	0.2275688	0.4477012	0.4841535
beta[2]	-0.0001474	-8.579e-05	0.0002189	0.0005306	0.0005821
beta[3]	-0.5963766	-4.666e-01	0.2486479	0.9952829	1.1611978
beta[4]	0.0062177	8.410e-03	0.0203513	0.0327862	0.0349948
beta[5]	-0.0948629	-8.533e-02	-0.0348704	0.0154370	0.0252623
beta[6]	-0.0008522	-6.798e-04	0.0001617	0.0010261	0.0012388

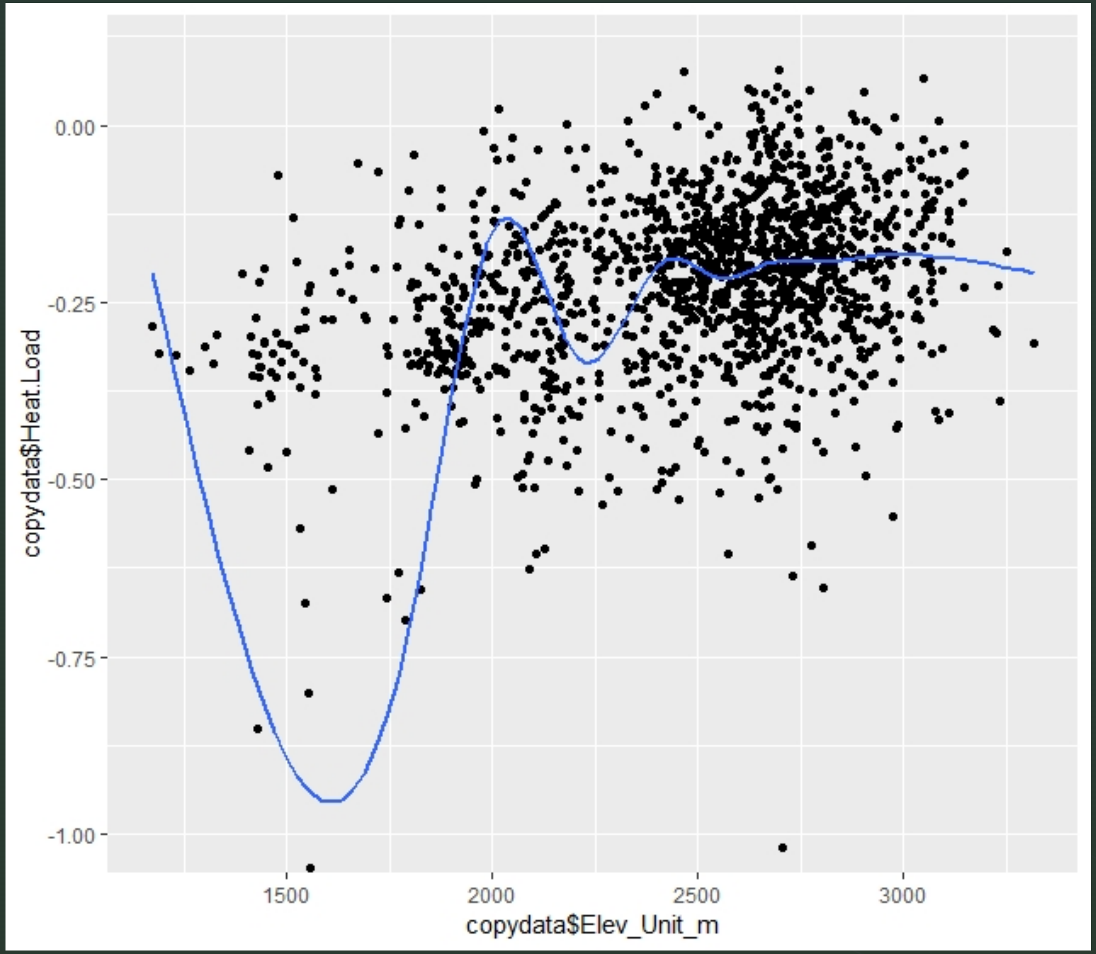


Plotted Data and Analysis



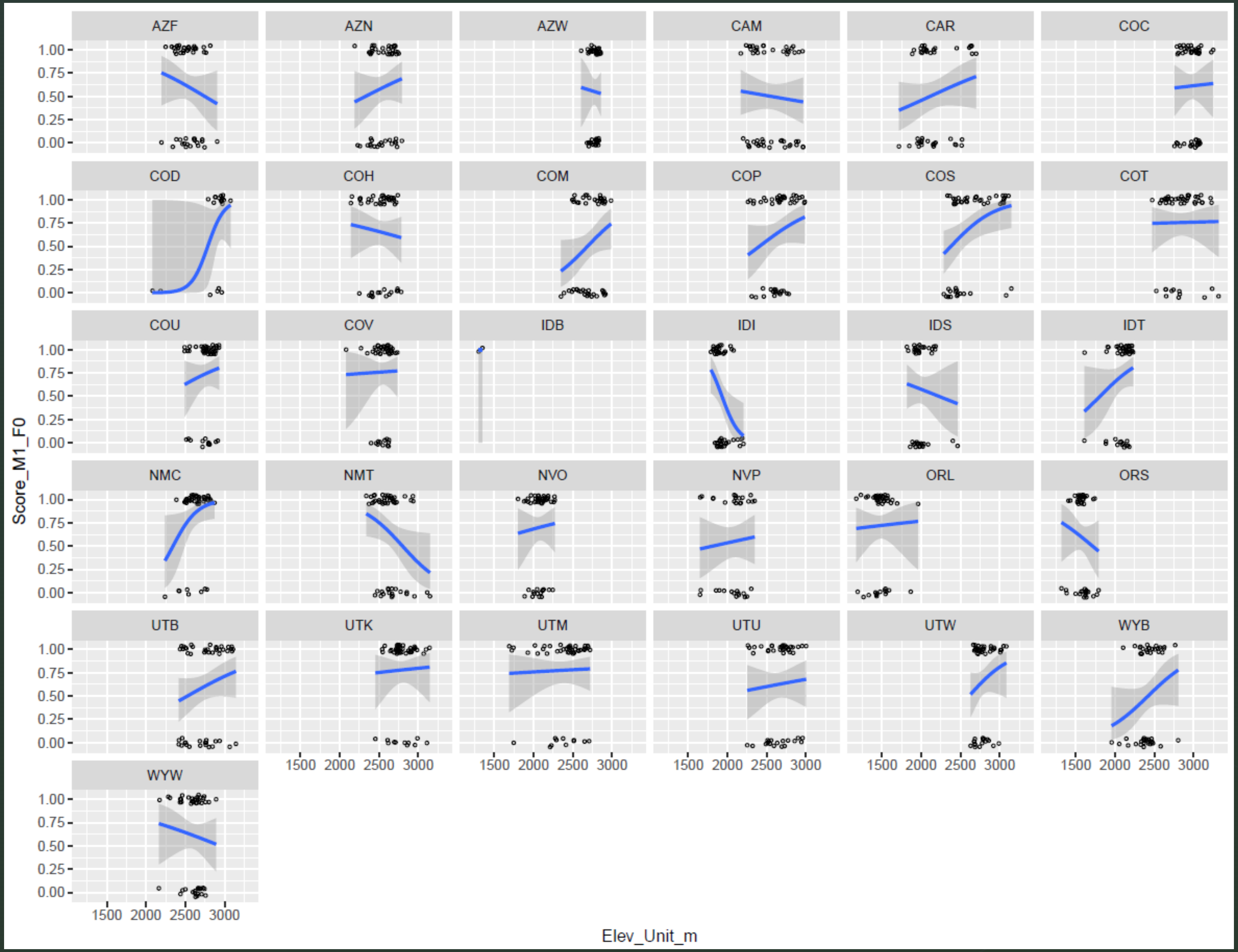
- Nearly 2:1 Male ratio overall (923 M to 529 F)
- Model = No effect of elevation

Plotted Data and Analysis



- 1 Site with very low heat load values (ORS)
- Model = No interaction

Plotted Data and Analysis



Discussion

- Effect of elevation ✕
- Effect of heat load ✕
- Effect of Latitude ✕
- Site Effect
- Interaction between elevation and heat load ✕

Future Work

- Create a hierarchical model by site
- Analyze different interaction terms
- Look into heat load outlier site

Literature

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Thanks for Listening! Questions?

Photo Credit – Michigan Department of Natural Resources