Growth Patterns and Survival of Fire Moss, *Ceratodon purpureus,* at an Extreme Temperature

Camille Graves

Masters Research

- Growing at extreme temperatures, bryophytes exhibit local adaptation
- Study System
  - Lassen Volcanic National Park, California
  - Species: *Ceratodon purpureus*
    - Growing at temperatures of 25-65° Celsius
- Experiment
  - Took clone individuals from 4 populations and measured survival while being grown in a growth chamber at 32° C

Local Adaptation vs. Phenotypic Plasticity

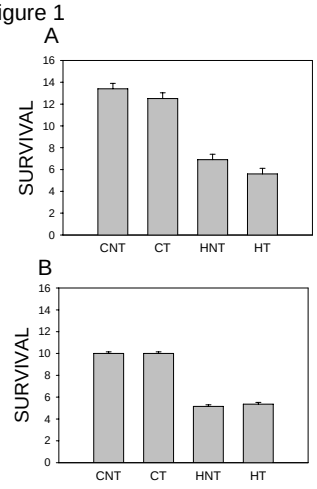
- **Local Adaptation** -A population will have the best performance in the habitat to which it is adapted
- **Phenotypic Plasticity –** Ability to change form under different environmental conditions
- Both allow individuals of a species to exist across a wide environmental gradient
- Both causes variations in a species among habitats

Results

Number of days survived by C. purpureus protenema for populations grown at cold temperatures that were from non-thermal sites (CNT), grown at cold temperatures from thermal sites (CT), grown at hot temperatures from non-thermal sites (HNT), and grown at hot temperatures from thermal sites (HT). Results from two separate experiments are shown.

Preliminary Conclusion: Phenotypic Plasticity

Figure 1

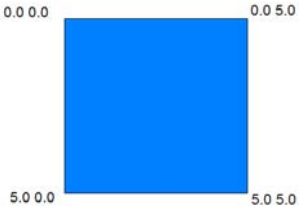


Searching for an Explanation

- Using Photos of moss from beginning of experiment:
  - Looked for correlation between moss area and Survival
    - Maximum Likelihood Classification
  - Looked for correlation between moss growth pattern (dispersal, clustered or random) and survival
    - Average Nearest Neighbor Analysis

Assign Coordinates to Picture

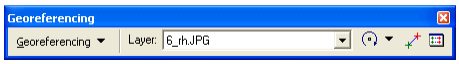
- Using a text file that denoted coordinate point
  - polygon
    1
    1 0.0 0.0
    2 0.0 5.0
    3 5.0 5.0
    4 5.0 0.0
    5 0.0 0.0
    END



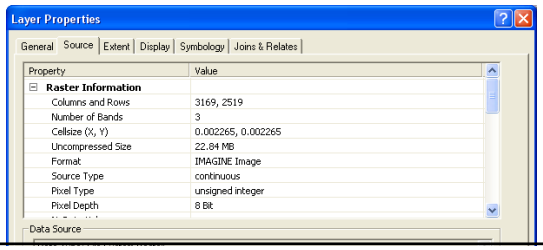
- Create shapefile from this text file
  - Arc toolbox: Samples/Data Management/Features/Create Features From Text File

Assign Coordinates to Picture

- Using Georeferencing tool
  - Create control points from picture to coordinate shapefile
  - Once 4 corners are assigned select Rectify

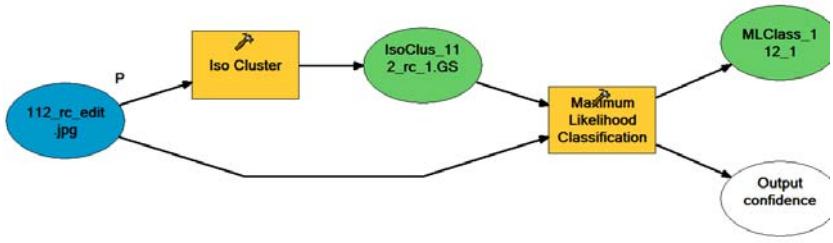


- Now each pixel has a size

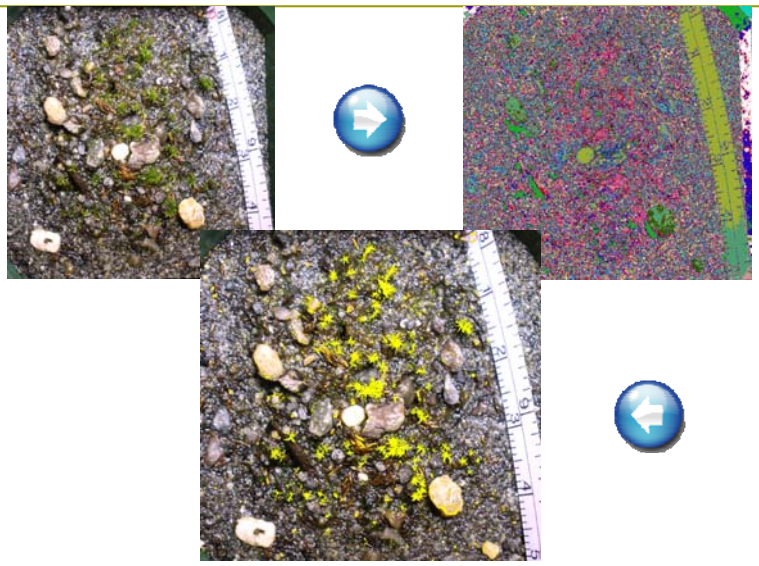


Classify Moss

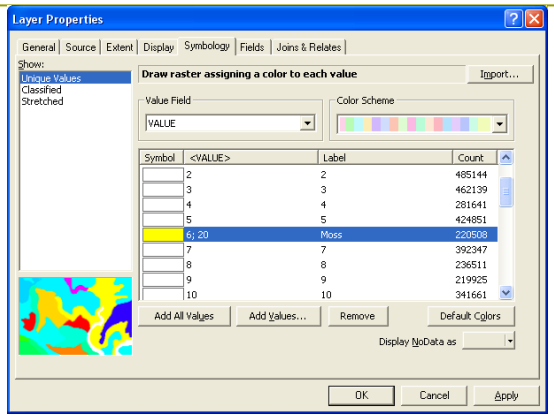
- Iso Cluster
  - Creates Signature file which is a clustering of the multivariate data (colors in this case) combined in a list of input rasters
  - 30 classes of color
  - Arc Toolbox/Spatial Analysis Tool/Multivariate/Iso Cluster
- Maximum Likelihood Classification
  - Assigns each cell to a class
  - Arc Toolbox/Spatial Analysis Tool/Multivariate/Maximum Likelihood Classification



Classify Moss



Classify Moss

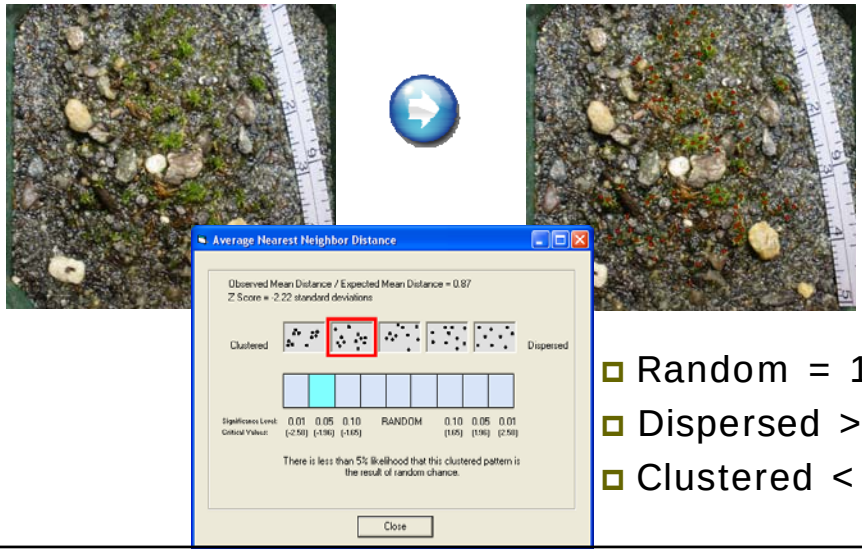


- Area
  - Pixel size * pixel count = area (cm)
  - .0022^2 * 220508 = 1.06 cm

Average Nearest Neighbor Analysis

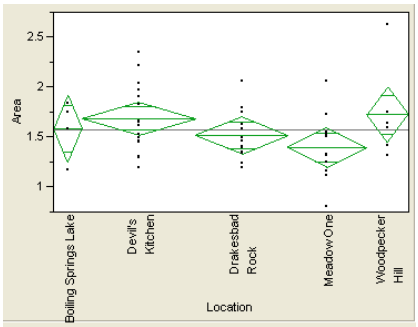
- Create point shapefile
- Using editor assigned point to center of each moss ramet
  - To test for error, repeated placing points but randomly place points to left, right, up or down from center point. Average error for analysis was 0.03
- Using these point ran Average Nearest Neighbor Analysis
  - Arc Toolbox/Spatial Statistics/Analyzing Patterns/Average Nearest Neighbor

Average Nearest Neighbor Analysis



- Random = 1
- Dispersed > 1
- Clustered < 1

Results - Area



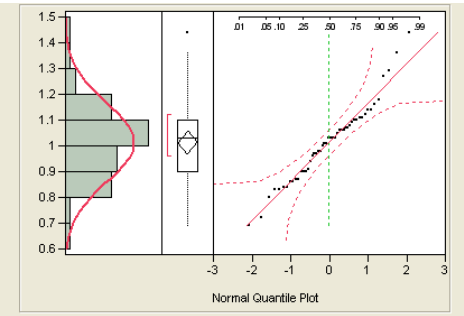
- P-value = .173
  - Not significantly different

Correlations

		Survival	Area
Survival	Pearson Correlation	1	-.028
	Sig. (2-tailed)		.846
	N	50	50
Area	Pearson Correlation	-.028	1
	Sig. (2-tailed)	.846	
	N	50	50

- P-value = .846
  - There is NOT a significantly correlation between area and survival

Results – Nearest Neighbor



Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.975008	0.3652

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

- Normal Distribution
  - Divided values into thirds for Clustered, Random and Dispersed

Results – Nearest Neighbor

- P-value = 0.031
  - Significantly different

Preliminary Conclusion

- Nearest Neighbor effect survival and Area does not
- Being Clustered may help the moss survival in extreme temperatures
- More Research
  - Experiment to test Survival between Cluster and Dispersed
  - Test for different Growth Patterns between Populations
  - Try to minimize difference between individuals