Spatial Simulation of Chaparral Plants with Frequent Wildfire

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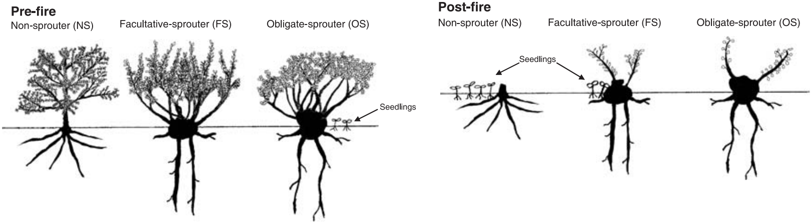
Chaparral Vegetation and Fire Frequency in the SMM

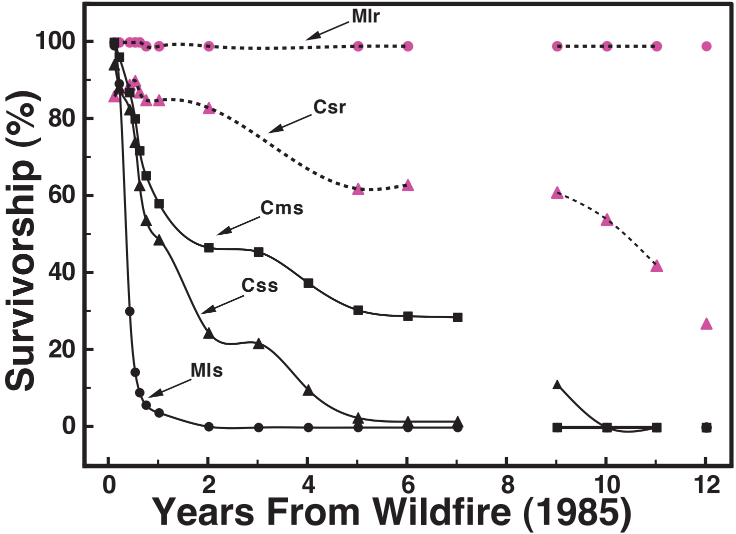
- Chaparral shrubs represent the dominant vegetation type in the Santa Monica Mountains (SMM).
- The deep roots of chaparral shrubs are responsible for keeping the hillside in tact.
- Recent increase in fire frequency in the SMM
  - Santa Monica Mountains, 1925-2001:
    Average time between fire was 32 years
  - Malibu Study Site, 1985-2011:
    Average Time Between Fire was just over 6 years
- Frequent wildfires have altered plant community structure.
  - Localized extinction of particular chaparral species.
  - Invasion of exotic grasses that increase flammability.
- Reduction in vegetation cover leads to decrease in slope stability, e.g erosion, mudslides.

Three Life History Types

- (NS) Nonsprouters are completely killed by fire and reproduce by seeds that germinate in response to fire cues.
- (OS) Obligate sprouters are not completely destroyed by fire but resprout from the root crown. OS recruit seedlings in the shade between wildfires because seeds are destroyed by fires.
- (FS) Facultative sprouters both resprout and reproduce by seeds that germinate in response to fire cues.



Species Survivorship Data



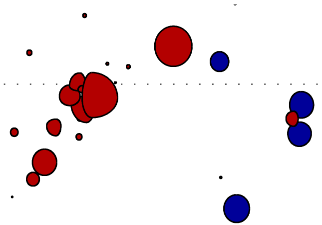
Changing Landscape

Comparison of frequently and non-frequently burned sites.

Simulation Goals

Goal: Model individual plants on a preset grid.
Plant attributes:

- Size (Height and crown size)
- Reproduction by seeds and/or resprouting
- Response to wildfires



Variables to consider:

- Annual rainfall and effect on plant growth
- Seed dispersal and germination
- Seedling survival and time to reproductive maturation
- Fire return intervals

Simulating Fire Return Intervals

Poisson Distribution

$$f(k;\lambda) = \frac{\lambda^k e^{-\lambda}}{k!}$$

Pros

- Easy to estimate λ.
- Discrete

Cons

- Rigid distribution

Weibull Distribution

$$f(x;\beta,\eta) = \frac{\beta}{\eta}\left(\frac{x}{\eta}\right)^{\beta-1} e^{(-x/\eta)^{\beta}}$$

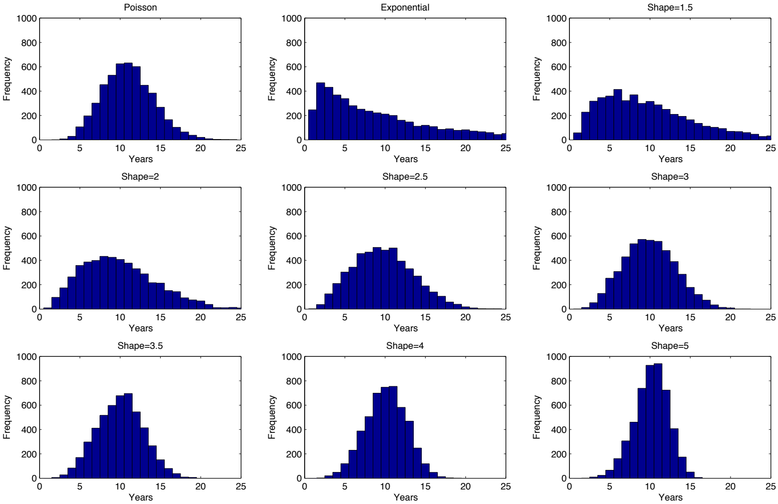
Pros

- Aging Effect/Build up
- Flexible

Cons

- Difficult to estimate β, η.

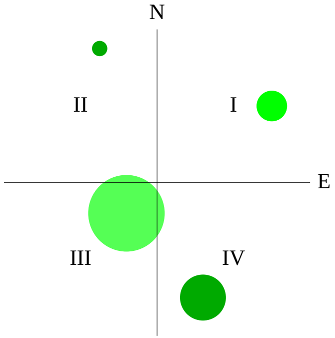
Comparing Distributions



Field Work

Point Quarter Sampling Method

- 32 poles are laid out on a 4×8 grid, placed 10m apart.
- Meter stick is placed at each pole oriented N-S, another stick is laid perpendicular creating 4 quadrants.
- Classified closest plant to pole in each quadrant based on location of base.
- Measured distance to pole, height, crown diameter, and base diameter.
- Inspiration for how we will arrange the plants in our simulation.



Field Work

Analysis of Point Quarter Data from 1985-2012

Used sampling data to estimate information about rest of site

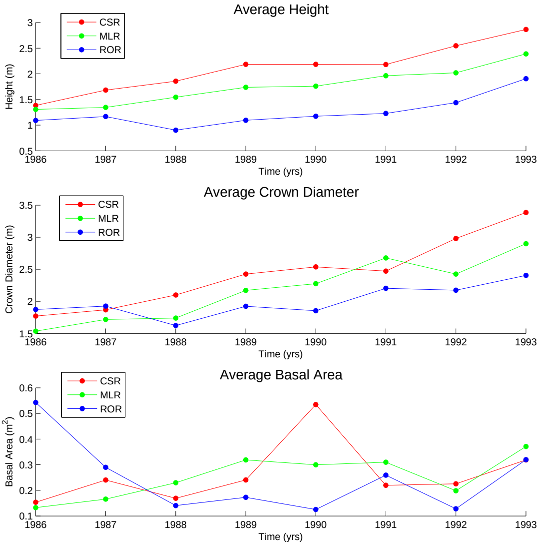
- Frequency of a species
- Density of a species
- Crown and Basal Dominance

Gaining context from taking data ourselves

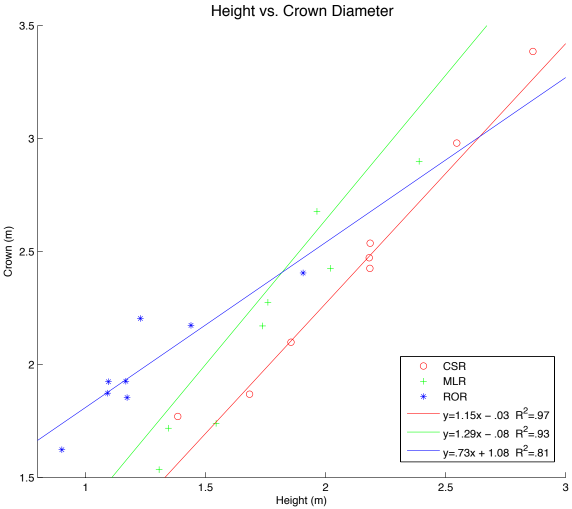
- Height is most accurate measurement.
- Basal diameter is difficult to measure for resprouts, since it is hard to separate plant bases.
- Able to make judgement calls when working with growth curves and interpreting data.
- Understanding the shape of plants, plant collisions, species dominance.

Measurements

Yearly Growth Averages (1985-1993)

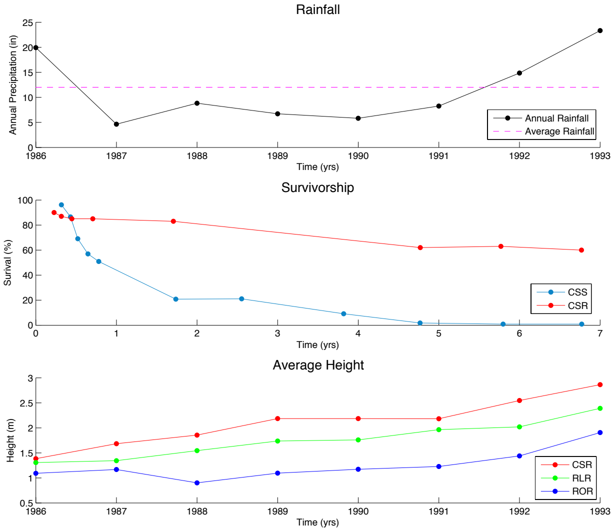


Correlation Between Height and Crown Size



Based on average values from years 1986-1993

Correlation with Rainfall

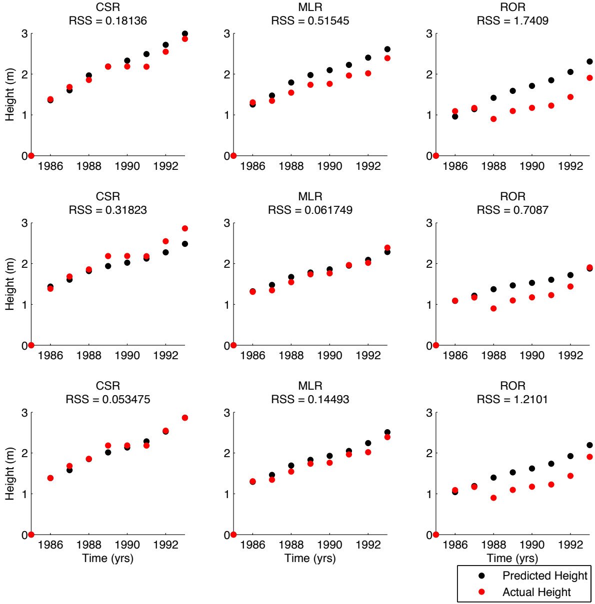


Estimating Change in Height (1985-1993)

$$\Delta h(w,t) = awe^{-bt}$$

$$\Delta h(w,t) = \frac{aw}{t}$$

$$\Delta h(w,t) = \frac{aw}{t^b}$$

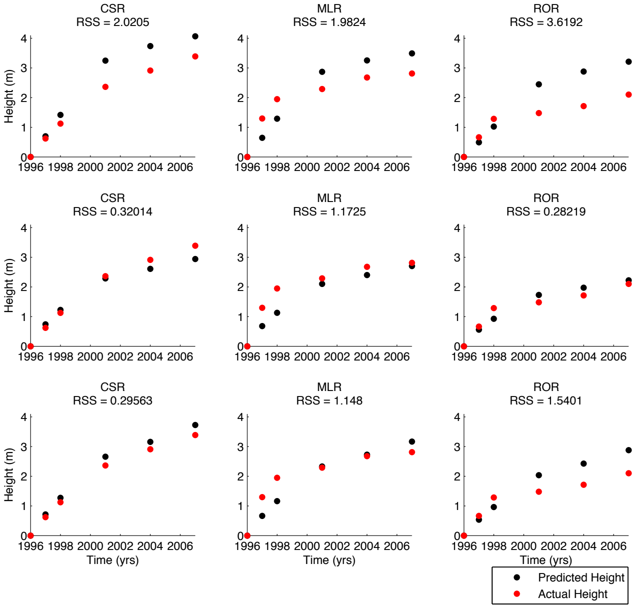


Projecting Change in Height (1996-2007)

$$\Delta h(w,t) = awe^{-bt}$$

$$\Delta h(w,t) = \frac{aw}{t}$$

$$\Delta h(w,t) = \frac{aw}{t^b}$$



Resources